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# THE PLANT DISEASE REPORTER

Issued By

## THE PLANT DISEASE SURVEY

Division of Mycology and Disease Survey

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

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The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Division of Mycology and Disease Survey serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

# THE PLANT DISEASE REPORTER

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THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY

Plant Industry Station — Beltsville, Maryland

Volume 30 — July 15, 1946 — Number 7


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## CHECK LIST REVISION

Freeman Weiss

### VICIA (LEGUMINOSAE)

VICIA AMERICANA Muhl. ex Willd., AMERICAN VETCH (1), including the vars. OREGANA (Nutt.) A. Nels. and TRUNCATA (Nutt.) Brewer; V. CAROLINIANA Walt., CAROLINA V. (2); V. CRACCA L., COW V. (3); V. SPARSIFOLIA Nutt., STIFFLEAF V. (4). Widely distributed native perennials, (1) more frequent east and north, (2) mostly southern, and (3) western. All are important food plants for wildlife.

Ascochyta pisi Lib., leaf spot. Calif. (1), Wis. (1,2), Oreg. (4) Reported also as A. viciae Lib., which is generally regarded as a synonym; the identification as A. pisi on native vetches has been questioned but is tentatively accepted because of its demonstrated pathogenicity to cultivated spp. of vetch. See also Mycosphaerella pinodes.

Cercospora viciae Ell. & Holw., leaf spot. Mich., Wis. (2)

Erysiphe polygoni DC., powdery mildew. Mo. (1), Mont. (1,4), Oreg. (4)

Gloeosporium davisii Ell. & Ev., on pods. Wis. (1)

G. everhartii Sacc. & Syd., on leaves. Wis. (1)

Microdiplodia viciae Pk., on leaves. Kans. (1,4), N. Mex. (1), Calif. (4)

Microsphaera alni DC. ex Wint., powdery mildew. Ida., Ill., Mont., Oreg., N. & S. Dak., Wyo., Wash. (1); Mont. (4). Var. ludens Salm., Oreg., S. Dak., Wyo. (1); Colo., Mont., S. Dak., Wyo.(4). Var. vaccinii (Schw.) Salm., Wash. (1); Wyo. (3).

M. diffusa Cke. & Pk. Mont., S. Dak., Wyo. (1)

Mycosphaerella pinodes (Berk. & Blox.) Vest., on stems. N. Y. (1,2). This report may refer to the pycnidial stage only and actually be Ascochyta pisi Lib.

Peronospora narbonensis Gäum., downy mildew. Colo., Iowa, Kans.(1). The fungi reported variously on this host as P. viciae (Berk.) Casp., P. viciae-americanae J. J. Davis, and P. viciae-sativae Gäum. in N. and S. Dak. and Wis. are probably identical. It is at least physiologically distinct from P. viciae on cult. spp. of vetch.

Phleospora reticulata Ell. & Ev., on leaves. Wis. (1)

Septoria astragali Desm., leaf spot. Wis. (1)

Thecaphora deformans Dur. & Mont., seed smut. Utah (1,3), N. Y. (2)

Uromyces coloradensis Ell. & Ev. (0,I,III), rust. Ind. and Wis. to N. Mex., Calif. and Wash. (1,4); Wis. (2); Utah, Wyo. (3) 3 varieties are distinguished by Arthur: campester, ranging from Ind. to N. Mex. and Mont.; montanus, from Colo. and Mont.

Vicia cont.

to Wash.; maritimus, on the Pacific Coast.
U. fabae (Pers.) DBy. (O,I,II,III), rust. General (1); Wis. (2), Conn., Vt. (3); Minn. to Ariz. and Oreg. (4).

VICIA ANGUSTIFOLIA Grufberg, NARROWLEAF VETCH (1); V. SATIVA L., COMMON V. (2). European annuals; (1) sometimes grown for winter cover and soil improvement in the South, and widely established in fields and waste ground; (2) commonly grown for forage and winter cover in the South, and for hay and seed in the Pacific Coast States.

Aphanomyces euteiches Drechs., root rot. Ala., Wis. (2)
Ascochyta sp., leaf and pod spot, Mich. (2); foot rot, Ala. (2). Besides A. pisi and Mycosphaerella pinodes, which are reported as naturally infecting this host, A. pinodella L.K. Jones can infect it by artificial inoculation.
A. pisi Lib., (A. viciae Lib.), leaf spot. Ga., Miss., N. & S. Car., Wis. (1); Del., Ga., Miss., N. Car., N. Y., Oreg. (2).
Botrytis cinerea Pers. ex Fr., leaf blight. Fla., Ga. (1,2)
Cercospora viciae Ell. & Holw., leaf spot. Iowa, Kans., Md. (2).
Colletotrichum villosum Weimer, anthracnose. Fla., Ga. (1,2), perhaps also La. (2).
Fusarium oxysporum Schlecht. f. medicaginis (Weimer) Snyder & Hansen, wilt, root rot. Ala., Miss. (2)
Heterodera marioni (Cornu) Goodey, root knot. Calif., Tex. (2)
Kabatiella nigricans (Atk. & Edg.) Karak., false anthracnose, stem and pod spot. Va. (1); N. Y., N. Car. (2)
Mycosphaerella pinodes (Berk. & Blox.) Vest., leaf spot. Wis. (1), N. Y. (2)
Ovularia schwarziana Magn., leaf spot. Wash. (2)
Peronospora mayorii Gäum., downy mildew. Md. (1). Perhaps only a form of the following.
P. viciae (Berk.) Casp. Md., Ga., N. Car. (1); Md., Mass., Miss., Oreg., Va. (2). On the latter host also reported as P. viciae-sativae Gäum.
Phymatotrichum omnivorum (Shear) Dug., root rot. Tex. (1,2)
Pleosphaerulina hyalospora (Ell. & Ev.) Berl., leaf spot. Miss. (2)
Sclerotinia trifoliorum Eriks., stem rot, wilt. Calif., Oreg. (2)
Septoria viciae West., on stems. Oreg. (2)
Thielaviopsis basicola (Berk. & Br.) Ferr., root rot. Mass.
Uromyces fabae (Pers.) DBy. (O,I,II,III), rust. Calif., Mass., Mont., Wash. (2)

VICIA FABA L., BROADBEAN, HORSEBEAN. Annual of Mediterranean region, cult. since antiquity for edible seeds; in the U. S. grown in Calif. and occasionally elsewhere as a garden crop, and in the

Vicia cont.
South as a winter annual for soil improvement and stock feed.

Alternaria tenuis Nees ex Wallr., secondary leaf and stem spot, also on seed. Calif., Ida.
Ascochyta pisi Lib., leaf and pod spot. Calif., La., Ohio
Botrytis cinerea Pers. ex Fr., gray mold leaf spot. Fla., Ga., N. Y., Alaska
Fusarium culmorum (W. G. Sm.) Sacc. and F. trichothecioides Wr., root rot. Utah.
Heterodera marioni (Cornu) Goodey, root knot. Calif.
Mycosphaerella sp., leaf spot. La.
Phymatotrichum omnivorum (Shear) Dug., root rot. Tex.
Pythium spp., root rot, damping off. Calif., Hawaii. The following specifically identified: P. arrhenomanes Drechs., P. debaryanum Hesse, P. graminicola Subr., P. irregulare Buis., P. rostratum Butl., P. splendens Braun.
Rhizoctonia solani Kuehn, root and stem rot. Mich., Wash.
Sclerotinia sclerotiorum (Lib.) DBy., stem rot. Calif.
Sclerotium rolfsii Sacc., southern blight. Fla., P.R.
Uromyces fabae (Pers.) DBy. (O,I,II,III), rust. Ala., Calif., Kans., La., Miss., N. Car., Pa., Tex.
?Xanthomonas phaseoli (E.F. Sm.) Dowson, bacterial blight. La.

Curly top -- virus (Chlorogenus eutetticola Holmes). Calif.
Mosaic -- virus (es). Calif., Ind., La., N. J., Va. The following viruses have been identified in natural infections: Marmor pisi Holmes and M. trifolii Holmes in N. J.; M. efficiens F. Johns. and ? M. repens F. Johns. in Wash. Susceptibility to artificial inoculation by the following viruses has been shown: alfalfa mosaic, common and yellow bean mosaic, common pea mosaic, pea streak, and cucumber mosaic including the lima bean strain.
Spotted wilt -- virus (Lethum australiense Holmes). Calif., Hawaii

VICIA VILLOSA Roth, HAIRY VETCH (1); V. ATROPURPUREA Desf., PURPLE V. (2); V. PANNONICA Crantz, HUNGARIAN V. (3). European annuals, grown for hay, forage, and soil improvement; (1) is hardy in the Northern States, (2) and (3) are grown chiefly in the Pacific Coast States and the far South.

Ascochyta sp., leaf and pod spot. On (1) throughout its range; sometimes identified as A. pisi Lib. (A. viciae Lib.) but is probably the conidial stage of Mycosphaerella pinodes.
Botrytis cinerea Pers. ex Fr., gray-mold leaf spot. N. Y.
Colletotrichum viciae Dearn. & Overh., anthracnose. La., Md., Miss., Pa., Wis. (1).
C. villosum Weimer, anthracnose. Fla., Ga. (1,2,3); Okla. (1)
Fusarium oxysporum Schlecht. f. medicaginis (Weimer) Snyder & Hansen, root rot. Miss.
Heterodera marioni (Cornu) Goodey, root knot. Gulf States, Calif.

Vicia cont.
(1,2), R. I. (1)
Kabatiella nigricans (Atk. & Edg.) Karak., false anthracnose. La., Miss., Mont., N. Y., N. & S. Car., Ohio, Oreg., Tenn., Wis. (1); Oreg. (3)
Mycosphaerella pinodes (Berk. & Blox) Vest., leaf and stem spot. Ga., N. Y., S. Car., Wash. (1); Oreg. (3)
Ovularia schwarziana Magn., leaf and stem spot. Ida., Oreg. (1); Wash. (2). Apparently the same fungus is reported as O. viciae (Frank) Sacc., on (2) in Wash.
Peronospora viciae (Berk.) Casp., downy mildew. Miss., N. & S. Car. (1)
Pseudomonas pisi Sackett, bacterial blight. Calif. (2)
Pseudopeziza ?medicaginis (Lib.) Sacc., leaf spot. Miss. (1)
Rhizoctonia solani Kuehn, root and stem rot. Ill.
Sclerotinia sp., stem rot. Calif. (1)
S. trifoliorum Eriks., wilt, stem rot. Oreg. (2)
Septoria pisi West., leaf spot. Ga. (1)
S. viciae West., on stems. Oreg. (3)

VIGNA (LEGUMINOSAE)

VIGNA CYLINDRICA (L.) Skeels (V. catjang Walp.), CATJANG PEA (1), and V. SINENSIS (Torner) Hassk., COWPEA (2). Annuals, probably originally of eastern Asia, widely cult. for forage, soil improvement, and edible seeds. Various types of (2) especially are grown in the U. S., chiefly in the South; these intergrade with (1) and to some extent with V. sesquipedalis (see below).

Alternaria sp., A. atrans Gibson (probably = A. tenuis Nees ex Wallr.), leaf spot (secondary), tip burn. Ariz., Del., Ill.(2)
Aristastoma oeconomicum (Ell. & Tracy) Tehon, late or white leaf spot. Miss. (1); Conn. to Fla., Tex. and Ill. (2).
Ascochyta spp., leaf & pod spot. Del., Md., Tex. (2). A pisi Lib. reported in Tex.; A. phaseolorum Sacc. (?) in Md.
Botrytis cinerea Pers. ex Fr., gray mold blight, pod rot. Calif., Del., Md., N. J. (2)
Cercospora canescens Ell. & G. Martin, leaf spot. Miss., Va., W. Va. (2). Sometimes considered a synonym of the following.
C. cruenta Sacc. (= Mycosphaerella cruenta Latham), leaf spot. Ark., Del., Fla., La., Tenn. (1); N. J. to Fla., Tex., and Kans. (2)
(C. vignae Ell. & Ev.): C. cruenta.
(C. vignae Rac.): C. vignae-sinensis Tai.
Though reported on cowpea in P. R., the applicability of this name to American material is doubtful.
C. vignicola Tehon, on stems. Ill. (2) Associated with Glomerella vignicaulis.

Vigna cont.

Chaetoseptoria vignae Tehon, leaf spot. Ill. (2)

Choanephora cucurbitarum (Berk. & Rav.) Thaxt., pod rot. Ga., La., Miss., N. Car. (2)

Cladosporium vignae Gardner, leaf and pod spot. Del. to Ala., Ind., and Tex. (2)

Colletotrichum spp., anthracnose. Occasional. (2) Identified as C. caulicolum Heald & Wolf (= C. truncatum (Schw.) Andrus & W. D. Moore) in La.; as C. lindemuthianum (Sacc. & Magn.) Briosi & Cav. in Ala., Del., Fla., Ill., and Okla.

(Corticium koleroga (Cke.) Hoehn.): Pellicularia koleroga.

C. microsclerotia Weber and C. solani (Prill. & Del.) Bourd. & Galz. See Pellicularia filamentosa.

Diaporthe phaseolorum (Cke. & Ell.) Sacc., var. sojae (Lehman) Wehm., on stems. Ga., Md., Va. (2)

Diplodia natalensis Pole-Evans (= Physalospora rhodina (Berk. & Curt.) Cke.), on stems & pods, ? dieback. Tex. (2)

Erysiphe polygoni D C., powdery mildew. Conn. to Fla., Kans., and Calif. (2)

Fusarium oxysporum Schlecht. f. tracheiphilum (E. F. Sm.) Snyder & Hansen, wilt. General in the Southern States from Va. to Fla., Mo. and Tex., but largely controlled by use of resistant vars. Possibly other forms of F. oxysporum, as F. o. vasinfectum (E. F. Sm.) Snyder & Hansen (formerly confused with Neocosmospora vasinfecta E. F. Sm.), also are involved.

F. solani (Mart.) App. & Wr. f. phaseoli (Burk.) Snyder & Hansen, root rot. Calif., Miss., N. Y., Okla.

Glomerella vignicaulis Tehon, on stems, ? stem blight. Ill., ? La. (2)

Helminthosporium vignae L. S. Olive, target spot. Fla., Ga., La., N. & S. Car. (2)

Heterodera marioni (Cornu) Goodey, root knot (2). General in the South from Va. to Fla., Mo. and Calif., but usually avoided by growing resistant vars., Iron and Brabham being nearly immune; reported on this host also in R. I. and Hawaii.

Leptosphaerulina vignae Tehon & Stout, leaf spot. Ill. (2)

Macrophoma subconica Ell. & Ev., stem canker. Ala., Ill. (2)

Macrophomina phaseoli (Maub.) Ashby, ashy stem blight, charcoal rot. Ark., Calif., Ga., Ill., Md., N. Car., Okla., Tex. (2)

Microsphaera alni DC. ex Wint., powdery mildew. Fla., Ga., Ind., S. Car. (2).

Mycosphaerella cruenta Latham. See Cercospora cruenta.

M. pinodes (Berk.& Blox.) Vest., leaf spot. S. Car. (2).

Myrothecium roridum Tode ex Fr., leaf spot. La., Miss. (2)

Nematospora phaseoli Wingard (? N. coryli Pegl.), yeast spot (of seed). Ill., Va. (2)

Pellicularia filamentosa (Pat.) Rogers (Rhizoctonia solani Kuehn), stem canker. General (2). Also reported as C. microsclerotia Weber, web blight, in Fla.

Vigna cont.

Pellicularia koleroga Cke. (Corticium stevensii Burt), leaf blight. N. Car. Reported as Hypochnus ochroleucus Noack.

Peronospora trifoliorum DBy., downy mildew. N. J., Va. (2)

Phoma bakeriana Sacc., pod spot. Miss. (2) Perhaps the same fungus is reported as P. lathyrina Sacc. from Ill., and both may be forms of the following.

Phyllosticta phaseolina Sacc., leaf spot. Del. to S. Car., Okla., and Mich. (2). Perhaps secondary to bacterial spot.

Phymatotrichum omnivorum (Shear) Dug., root rot. Ariz. (1) Okla., Tex. (2)

Pseudomonas phaseolicola (Burk.) Dowson, bacterial spot, ? halo blight. Ga. (2). Not clearly differentiated from the bacterial spots caused by P. syringae and Xanthomonas vignicola, perhaps doubtful, as is also P. pisi Sackett reported on this host in Tex.

P. syringae Van Hall, bacterial spot, red spot. Conn. to Fla., Tex., and Kans. (2)

P. tabaci (Wolf & Foster) Stapp, wildfire. Fla. (2)

Pythium spp., root rot, damping off. Ariz., Calif., Hawaii (2). The following spp. identified: P. artotrogus (Mont.) DBy., Hawaii; P. debaryanum Hesse, Calif., Hawaii; P. splendens Braun, Hawaii; P. ultimum Trow, Calif.

Rhizobium japonicum (Kirchner) Buchanan, or some other strain of the R. leguminosarum groups, bacterial nodule. Widespread in soils where cowpeas are grown (1,2).

Rhizoctonia spp., stem canker, sore shin, leaf blight. For R. microsclerotia Matz, R. solani Kuehn and ? R. dimorpha Matz see Pellicularia filamentosa.

Rotylenchus reniformis Linford & Oliveira, root nematode. Hawaii (1).

Sclerotinia sclerotiorum (Lib.) DBy., stem rot. Tex. (2)

Sclerotium bataticola Taub. See Macrophomina phaseoli

S. rolfsii Sacc., southern blight. Gulf States, Ill., N. Car. (2)

Septoria melanophthalmi Berk. & Curt., ? leaf spot. N. Car. (2)

Stagonospora phaseoli Dearn. & Barth., leaf spot. Tex. (2)

Thielaviopsis basicola (Berk. & Br.) Ferr., root rot. Md. (2)

Tylenchus brachyurus Godfrey, root nematode. Hawaii.

Uromyces phaseoli (Pers.) Wint. var. vignae (Barcl.) Arth. (0, I, II, III), rust. Hawaii (1); widespread (2), reported from Md. to Fla., Tex., and Kans., also Calif., but occurs mostly on Blackeye and related vars.; most cowpea vars. in the U. S. are immune.

Verticillium albo-atrum Reinke & Berth., wilt. Calif. (2)

Xanthomonas vignicola Burk., bacterial blight. Tex. (2) Reports of X. phaseoli (E. F. Sm.) Dowson on cowpeas in Ala., Ill., Miss., and Okla. probably relate to this organism, since X. phaseoli is not pathogenic to Vigna.

Vigna cont.

Curly top - virus (Chlorogenus eutetticola Holmes, Ruga verrucosans Carsner & Bennett). Calif. (2)

Mosaic - virus(es). (? Marmor cucumeris var. vignae Holmes, in part). Ind. (1); N. J. to Ala., Tex., and Kans., also Calif. and P. R. (2). The virus to which this name was applied originated as a mutant strain or segregate from cucumber mosaic virus; the naturally occurring cowpea mosaic virus is not known to be identical but has similar properties. Several other viruses are artificially communicable to cowpea, but cause local lesions (necrotic spots), as alfalfa mosaic, including the potato calico strain; most strains of cucumber mosaic; including the lima bean strain; pea wilt, and tobacco ringspot.

Chlorosis - nutrient deficiency, especially manganese and perhaps other mineral nutrients. Ala., Tex.

Leaf bronzing, chlorotic spotting, marginal yellowing and burning - nutrient deficiency, chiefly of potassium. On acid soils in the Southern States.

VIGNA SESQUIPEDALIS Wight, ASPARAGUS-BEAN, YARDLONG B. Vine-like annual of eastern Asia, grown for edible seeds and as garden novelty.

Cercospora cruenta Sacc., leaf spot. Va.
Cladosporium vignae Gardner, leaf and pod spot. Ind.
Erysiphe polygoni DC., powdery mildew. Calif.
Pseudomonas syringae VanHall, bacterial spot. Ind.
Uromyces phaseoli (Pers.) Wint. var. vignae (Barcl.) Arth., rust. Hawaii.

Mosaic - unidentified seed-borne virus. Calif.

This issue completes the Check List Revision through the family Leguminosae and affords a favorable opening to discuss future plans for this project.

It is hoped to maintain henceforth a regular schedule of monthly publication of sections. Having found it advantageous to assemble in sequence the material pertaining to related plants, the practice will be continued of taking up at least the principal plant families integrally. The order in which these families are treated will be somewhat arbitrary with emphasis on those furnishing important agricultural crops, while those of minor economic importance will be temporarily skipped. Thus the next group to be taken up will be the Bromeliaceae, containing the important genus Ananas. This will be followed by Chenopodiaceae (Beta, etc.), Convolvulaceae (Ipomoea), Cruciferae (Brassica, etc.) and Malvaceae (Gossypium). All genera of economic importance in each family will be treated in one alphabetic sequence, whether they contribute

field crops, vegetables, or ornamentals. Arborescent genera, having already been covered in the initial series of this List, will be omitted. The resultant lack of alphabetic continuity in the preliminary edition of the Revised Check List will not affect its final form, as it is intended eventually to publish it in one alphabetic sequence of the Latin names of host genera.

Reprints of the sections comprising the Leguminosae will be distributed in the near future to those whose names are on the mailing list as having especially requested a file of the Check List separate from the Plant Disease Reporter. It is necessary to restrict the distribution of these reprints to those who require the List in their professional work and who will undertake to review it for errors and omissions. The present mailing list for reprints contains about 100 names, and it is necessary to keep it at about this number. However, every request for the regular receipt of these reprints will be considered on its merits, and complied with if the stock permits.

DIVISION OF MYCOLOGY AND DISEASE SURVEY

# ZOOSPORE DEVELOPMENT FROM OOSPORES OF PYTHIUM ULTIMUM AND PYTHIUM DEBARYANUM AND ITS RELATION TO ROOTLET-TIP DISCOLORATION

Charles Drechsler

Oospores of Pythium ultimum Trow taken from maizemeal-agar plate cultures 3 months old produced zoospores in moderate abundance within 18 hours after they were transferred to a thin layer of water in Petri dishes kept at a temperature of 10° C. During the 3 months a large proportion of the oospores had lost the internal organization distinctive of their resting condition; the large central reserve globule together with the conspicuous refringent body having disappeared, and the oospore wall having become reduced, through resorption of an inner layer, to somewhat less than half its original thickness. In the densely granular texture and obscurely vacuolate character of their protoplasmic contents, as also in the appearance of their diminished envelopes, the after-ripened oospores showed general resemblance to globose asexual spores (conidia) formed abundantly on the mycelial hyphae of the species. At 25° C they germinated promptly by production of a germ hypha, even without addition of fresh water, while they were undergoing microscopical examination after their removal to a glass slide. On shallow irrigation at a temperature of 10° C an evacuation tube mostly 3 to 6 μ wide above its frequently broadened base was pushed through the loosely surrounding oogonial envelope. After it had attained a total length of 10 to 40 μ the tube formed a hyaline cap of dehiscence, which soon yielded to permit the protoplasmic contents to migrate into a vesicle for conversion usually into 8 to 10 motile zoospores. After escaping from the vesicle and swimming about for a time the zoospores came to rest and rounded up into cysts mostly 8 to 10 μ -- rarely up to 13 μ -- in diameter. These commonly germinated by putting forth 1 or 2 germ hyphae mostly 2 to 3 μ wide, but rather often, again, they gave rise individually to a secondary motile zoospore by extending an evacuation tube 2.5 to 4 μ long and 2 to 2.5 μ wide.

Zoospore formation has not hitherto been recorded for Pythium ultimum. The operation of this familiar species and of P. debaryanum Hesse as damping-off parasites in seedling beds has little obvious relation to development of swarmers, since here spread of infection evidently is accomplished for the most part by rangy extension of extramatrical mycelium from one plant host to another. However, the frequent occurrence of P. ultimum, especially during the cooler wet portions of the growing season, as the cause of blackening of rootlet tips in various crop plants as well as in many uncultivated phanerogams, appears rather strongly suggestive of infection by swarmers. It seems likely that under natural conditions swarm-spore development in P. ultimum may take place more abundantly through germination of after-ripened oospores than through reproductive germination of sporangia (conidia) borne directly on mycelial hyphae; the behavior of the fungus inviting comparison

with such congeneric forms as P. anandrum and P. ostracodes. Addition of partly decayed leaf mold to maizemeal-agar plate cultures after the substratum has been well permeated by the fungus often results in very pronounced increase in number of oospores formed. It appears possible that leaf mold supplies substances that besides permitting more oospores to develop make them more capable of giving rise to swarmers.

The same treatment that evoked zoospore production in oospores of Pythium ultimum was successful, likewise, in evoking such production in oospores of P. debaryanum taken from maizemeal-agar plate cultures 2 months old. The evacuation tube extended through the oogonial wall is here noticeably shorter, usually measuring only 7 to 15 μ in total length. After discharge of the protoplasmic contents into a vesicle the persistent outer layer of the oospore wall was found surrounding a structurally separate sporangial membrane more often than in P. ultimum. Oospores of average size, here as in the case of P. ultimum, gave rise commonly to 8 or 9 motile swarmers which after coming to rest and encysting measured usually 8 to 9 μ in diameter; the encysted bodies here, too, sometimes giving rise individually to a motile secondary swarmer. Zoospore development in P. debaryanum, of course, does not require a temperature as low as 10° C, nor any substances not usually present in maizemeal-agar containing in suspension a moderate quantity of finely divided maizemeal; for often when microscopic examinations are carried out on sparingly moistened slabs excised from maizemeal-agar cultures 15 days old many of the subspherical asexual sporangia in favorable positions will promptly put forth an evacuation tube to give rise to motile swarmers, though the laboratory may have a temperature near 18° C. During prolonged wet periods P. debaryanum, like P. ultimum, can often be isolated in quantity from blackened rootlet tips of various crop plants. The dispersed distribution of rootlet tips at varying depths in the soil would seem to offer more scope for infection by zoospores than for infection by extramatrical mycelium.

DIVISION OF FRUIT AND VEGETABLE CROPS AND DISEASES

## TOBACCO BLUE MOLD IN GEORGIA

J. G. Gaines

The 1946 blue mold (Peronospora tabacina) attack in Georgia was the most destructive on record. From 85 percent to 90 percent of the tobacco plants in untreated beds were killed by mold. Less than 5 percent of the growers attempted to use the recommended control measures and these few got their crops out on time and had ample plants left over. Many growers who wished to use the paradichlorobenzene (PDB) gas treatment failed to use a heavy cover to hold in the PDB vapors. They broadcast the PDB crystals on top of the plants and left off the extra

cover. Mold was as destructive in these beds as in other untreated beds. Thousands of pounds of PDB were wasted in this manner. The recommended spray and dust treatments were compared at Tifton and these gave 100 percent blue mold control in protecting plant stands and in insuring against delay, and reduced defoliation due to disease more than 85 percent. No more disease was observed in properly treated beds in 1946, with the most severe outbreak, than in 1945 when the attack caused little or no real damage. Therefore, mold did not constitute a real disease problem in treated beds this year. As a result of the severe attack and the indifference of growers, less than 25 percent of the Georgia acreage was set on time. Approximately 75 percent of the allotted acreage was set by May first. Many growers, who lost fully 90 percent of their plants, had several times as many beds sown as necessary, and these will be able to set their expected acreage from the remaining 10 percent. Weather was favorable for transplanting throughout the month of April. With favorable transplanting conditions, growers will continue to set until after May 15, and the majority will put out the full field acreage.

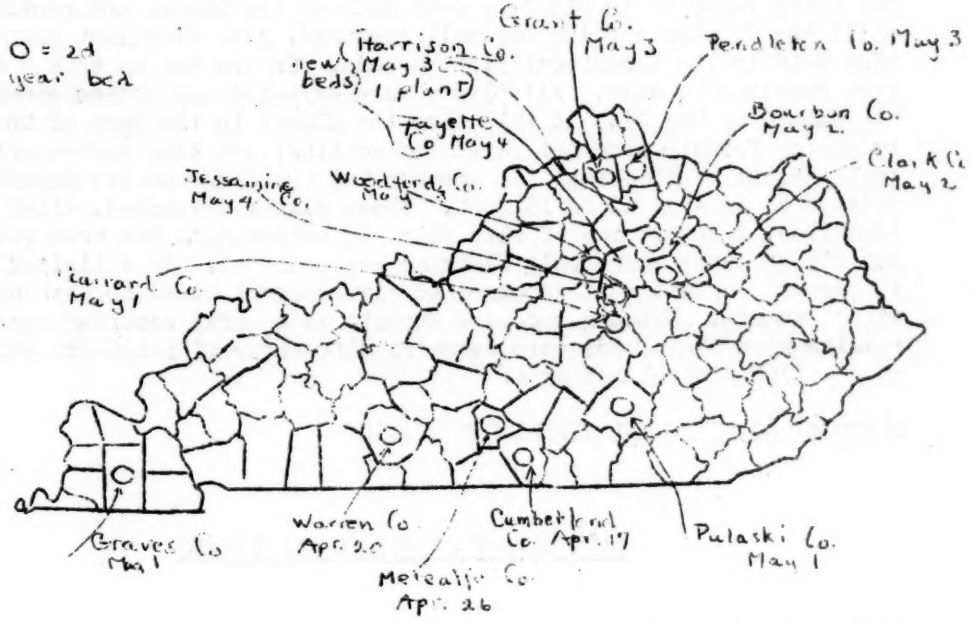
DIVISION OF TOBACCO, MEDICINAL, AND SPECIAL CROPS

## BLUE MOLD IN KENTUCKY IN 1946

W. D. Valleau and E. M. Johnson

Blue mold was first reported in Cumberland County April 17, in a bed used the previous year. At that time the disease had spread over the entire bed and so probably had been present in the bed for at least 2 weeks. That period and the remainder of the month were relatively dry. Rains commenced the last day of April and continued the first few days of May. By May 4 the disease was reported from the south to the north of the State (PDR 30: 201. June 15). The majority of these early reports were of beds that had been used the previous year and were evidently the result of carry-over. Infection was found in an occasional new bed as early as May 4. Carry-over was extensive in the State (see accompanying map) and, considering the wet weather throughout May (very frequent light showers), was evidently sufficient to account for the general infection that occurred later.

There has been some delay in setting, from blue mold, but probably the entire crop will be set. Considerable delay resulted from wet weather after plants were large enough to set in central Kentucky, and in some instances plants at setting time were considerably injured by blue mold because they could not be set by machine in wet soil. Yet the crop in central and southern Kentucky is probably the earliest set crop in at least 40 years. In northern Kentucky, burley beds were later than in central Kentucky, so many became diseased when the plants were small.


O = 2d year bed
Grant Co. May 3
Harrison Co. May 3 (new beds) 1 plant
Pendleton Co. May 3
Fayette Co. May 4
Bourbon Co. May 2
Clark Co. May 2
Jessamine Co. May 4
Woodford Co. May
Garrard Co. May 1
Warren Co. Apr. 20
Cumberland Co. Apr. 17
Graves Co. May 1
Metcalfe Co. Apr. 26
Pulaski Co. May 1

Setting is considerably delayed in the northern counties, partly because of late plants and partly because of inability to prepare the wet land for setting.

The 1946 outbreak was in marked contrast to that of 1945. In 1945 there was a gradual spread over the State from the south to the north, with no evidence whatever of any carry-over (no blue mold was reported in Kentucky in 1944), while in 1946 the outbreak seemed to be entirely from second-year beds.

The 1946 outbreak differed from that of 1938 (following the first general outbreak in the State in 1937) in that there was very little carry-over in 1938 but slow spread from the south to north with practically no damage. The 1946 outbreak was similar to the 1939 outbreak in that carry-over was general over the State; but in 1939, because of unfavorable weather conditions, blue mold was nearly completely confined to second-year beds until setting time or after.

Several small beds and two large beds of N. rustica remained free from blue mold after dusting or spraying with Fermate was discontinued, while neighboring burley plants became heavily infected.

Six dustings with Fermate (15 percent Fermate, 85 percent pyrophyllite), 2 pounds per 100 square yards, started on May 3, when blue mold was being reported in old beds over much of the State, and continued until May 22 when setting was well advanced, gave excellent control of blue mold in the Experiment Station beds. On one bed an area 9 by 30 feet received no dust. All plants were affected and showed considerable damage by May 21. At this time the plants in the part of the bed receiving Fermate were too large for setting; yet they showed only a small amount of flecking. In another bed the last two treatments were omitted in an area 12 by 15 feet. These plants developed, after setting time, a severe case of blue mold, in contrast to the area receiving six dustings where only flecking was observed. In a limited test 15 percent Zerlate dust appeared to give control equal to that obtained with Fermate. Growers who used Fermate as a spray reported excellent results when their beds were compared with those of neighbors who used no chemical control measures.

KENTUCKY AGRICULTURAL EXPERIMENT STATION

## LATE BLIGHT ON POTATO AND TOMATO

### LATE BLIGHT ON POTATO IN MARYLAND

By R. A. Jehle

Late blight (Phytophthora infestans) was found in all potato fields visited on the Maryland Eastern Shore on June 3 and 4. Only scattered infections were found in fields that had been sprayed or dusted with copper compounds. Some of the unsprayed fields and fields sprayed or dusted with insecticides were severely infected. In portions of some of the fields all of the leaves were killed and the vines were injured.

All potato growers in Maryland have been advised to spray their fields with Bordeaux Mixture or dust them with copper dusts.--University of Maryland, June 6, 1946.

### TOMATO LATE BLIGHT IN PENNSYLVANIA

By George L. Zundel

Last week I observed two patches of tomatoes, one in Cumberland County, the other in Lebanon County, both being grown for canning companies. The field in Lebanon County was planted with Georgia-grown

plants. Both fields were 100 percent infected with late blight. This disease is very prevalent in the State.--Pennsylvania State College. June 10, 1946.

## AN UNUSUAL OUTBREAK OF LATE BLIGHT ON TOMATO IN GEORGIA

By Julian H. Miller

The writer, with Mr. Rudulph Renfroe, Secretary, Chamber of Commerce at Glennville, conducted a survey of the tomato area in Tattnall County in southeast Georgia. The variety was Rutgers. In 20 fields inspected, May 15-16, 11 were planted in Florida-grown plants with an average leaf infection of 30% and fruit infection of 60%, with 4 fields running approximately 90% fruit rot. The other 9 fields were selected for inspection on the basis of home-grown plants; incidence in these was only a trace on leaf or fruit in 7 fields, and 30% on leaf and 90% fruit in one field, and 30% and 10% respectively in the other. The last two fields were adjacent to fields of Florida-grown plants. Small patches of potatoes also infected with late blight were within 50 to 200 yards of some of these fields. The weather conditions have been favorable for Phytophthora development, with cool nights and fairly frequent rains. According to reports from agricultural agents, the same condition prevails in all of the other tomato areas, such as Pembroke, Valdosta, and Moultrie. The loss in Tattnall County will be over 50% if no more rains fall during picking, and in many fields the loss is already approximately 100%. In addition, the buyers have dropped the price to less than half of last year's average, and are afraid to take the fruits at any price. Such an epiphytotic is difficult to explain, as late blight has been extremely rare in this area in past years, and usually occurs in Georgia only in the high mountain counties. The only two factors running through all centers are the slightly unusual weather and the use of Florida-grown plants from the same grower source.--Department of Plant Pathology, University of Georgia. May 22, 1946.

## LATE BLIGHT ON TOMATO FRUITS IN GEORGIA

By Edward K. Vaughan

Late blight (Phytophthora infestans) on tomato fruits from Camilla, Georgia, was first called to the writer's attention on May 7. At that time the county agricultural agent at Thomasville reported that the disease was causing severe losses in Grady, Mitchell, and Thomas Counties. In the week from May 7 to May 14, specimens were brought in from all of the "green wrap" producing counties of south Georgia, and by the latter date almost every field in this area was infected.

Buyers are refusing to buy apparently healthy fruit in most markets. Many of the growers reported that they had not yet started harvesting their crops, and now the vines and fruits are so severely damaged that they will not have any tomatoes to offer for sale.

For the last 11 days (May 3 to May 14) the affected area has had warm days, cool nights, and constantly high humidity. Unless these conditions change very quickly the entire production of "green wrap" tomatoes for the area appears to be doomed.--Division of Fruit and Vegetable Crops and Diseases, U. S. Bureau of Plant Industry, Soils, and Agricultural Engineering, Tifton, Georgia.

## OCCURRENCE OF CORKY RINGSPOT OF POTATOES IN FLORIDA

A. H. Eddins, E. Q. Procter and Erdman West

Corky ringspot (internal brown spot) of potatoes was observed at Hastings, Florida, in April, 1946. It occurs in European countries, the Dutch East Indies and South Africa, and was not previously known to be present in the United States. It was found in potatoes grown on 3 farms and caused losses varying from a trace to 50 percent of the tubers.

Symptoms of corky ringspot consist of brown, concentric rings and sections of rings on the surface of tubers. Some diseased tubers also show growth cracks and shallow, irregularly-shaped corky depressions on their surfaces. Brown corky areas appear in ring-like or irregularly-shaped patterns in the flesh of affected tubers. The disease mars the appearance of potatoes and makes them unfit for human consumption. Cause of the disease and means of controlling it are unknown.

The name, corky ringspot, is used for this disease because it is more descriptive of the concentric lesions and corky spots in the flesh of tubers than sprain or internal brown spot which was the name used for the same disease by Atanasoff (1) in Holland. Atanasoff stated that the disease occurred in numerous localities in the United States and Canada. However, there is no evidence which proves that it was present in the United States prior to its appearance in Florida this spring. Published descriptions and illustrations (2, 3, 4) show that physiological internal necrosis is the disease most commonly mistaken for corky ringspot or internal brown spot. Concentric lesions on the surface of tubers and the ring-shaped pattern of corky tissues in the flesh of tubers which are distinguishing characteristics of corky ringspot have never been mentioned in descriptions of any similar disease or injury of potatoes in America.

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3. Larson, R. H., and A. R. Albert. Physiological internal necrosis of potato tubers in Wisconsin. Jour. Agr. Res. 71: 487-505. 1945
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FLORIDA AGRICULTURAL EXPERIMENT STATION,
POTATO DISEASE INVESTIGATIONS LABORATORY, HASTINGS

## FUMES FROM 2-4-D CAUSE INJURY TO TOMATO, CABBAGE AND PEPPER PLANTS

E. M. Johnson and P. O. Ritcher

Unsprayed tomato plants about 8 inches tall and cabbage plants about 5 inches tall, growing in an experimental greenhouse, showed unusual injury from what appeared to be some volatile material in the air. On tomato the leaflets were narrow, twisted, and bent toward the petiole which drooped toward the stem. In a moist atmosphere guttation was prominent and water-soaking, which persisted for 48 hours when a plant was removed to a dry atmosphere, was present on many leaflets. On some plants the upper part of the stem appeared swollen. Cabbage plants had narrow twisted leaflets near the top and the petioles bent downward. The top portion of the stem appeared slightly swollen.

Because a similar appearance to that occurring on tomato had been observed on roses and chrysanthemums sprayed with a galvanized sprayer, previously used with the butyl ester of 2-4-dichlorophenoxy acetic acid and thoroughly washed three times with soap and hot water followed by rinsing three times, it was suspected that the tomato and cabbage plants were injured by this hormone. The only source of 2-4-D in the greenhouse was an open wheelbarrow sprayer used some time previously for spraying with the butyl ester of 2-4 dichlorophenoxy acetic acid and presumably washed with water. To test whether fumes from this sprayer could cause the injury described and to eliminate other gases as a cause, the wheelbarrow sprayer was placed in a screened insectary, open to the air on three sides. An 8-inch tomato plant and a 5-inch pepper plant were placed in the uncovered spray tank. In 48 hours the tomato plant showed injury like that occurring in the experimental greenhouse. The leaves of the pepper plant twisted and drooped downward and the plant bent near the top. Guttation and water-soaking were conspicuous on tomato leaflets and water droplets collected at the nodes when the

plant was removed to a dry atmosphere. The cuticle of the swollen upper stem eventually cracked and peeled off.

The wheelbarrow sprayer was then removed to another building. One plant each of tomato, pepper, and beet were placed in the uncovered spray tank. After 48 hours all showed drooping and twisting of the leaves. Three tomato plants and one cabbage plant placed on a table three feet from the open spray tank developed injury in 48 hours.

A ten-inch tomato plant was sprayed with water from a quart copper sprayer, that had been used about 10 days previously with the butyl ester of 2-4 dichlorophenoxy acetic acid and which, immediately after use, had been washed with three changes of hot soapy water followed by rinsing in clear water. The tomato plant developed typical injury when placed outside even though a heavy rain drenched the plant an hour after treatment. A tomato plant sprayed with water from the same sprayer, after rinsing with a saturated solution of tri-sodium phosphate and water, showed no injury.

It appears that some distributors of 2-4-D have not issued sufficient cleaning instructions following the use of this material to prevent injury to plants sprayed subsequently with the same equipment.

KENTUCKY AGRICULTURAL EXPERIMENT STATION, May 29, 1946.

## PLANT DISEASE SURVEY IN THE EVERGLADES AND CONTIGUOUS AREAS DURING THE 1945-46 SEASON

G. R. Townsend, R. C. Cassell, E. L. Felix, and Russell Desrosiers

BEAN Root rots (Rhizoctonia, Fusarium, and others). Fields of snap and lima beans on the sandy lands of the Coastal area were 100 percent affected by root rots throughout the season. Root rots caused general restriction of growth and reduction of yields but actual wilting and dying of mature plants was not widespread and average yields were maintained. This was no doubt due to the ample rainfall throughout the growing season. Root rots occurred in only slight amount in bean fields grown on muck soil in the Everglades.

Southern wilt (Sclerotium rolfsii) was observed to affect only occasional scattered plants.

Watery soft rot (Sclerotinia sclerotiorum). Although this disease appeared in epiphytotic proportions in bean fields of neighboring Broward County during December and January, the disease did not appear in Palm Beach County until late December and extended only a short distance into the southern part of the county. Following the outbreak of the disease,

weather conditions were unfavorable for its development in Palm Beach County and losses were too small to be considered significant.

Halo Blight (Phytomonas medicaginis var. phaseolicola) [Pseudomonas phaseolicola] occurred in only slight amounts in the Coastal area. In the Everglades it occurred in several hundred acres of beans in March on fields planted with seed produced in Wyoming. The loss of stand in infected fields was estimated at 30 percent. Heavy rains occurring after this observation was made spread the disease to all plants in these fields. Neighboring fields planted with Idaho certified seed remained blight-free.

Soil rot of pods (Rhizoctonia spp.) caused considerable damage to pods touching the ground in Everglades fields following the heavy rains of mid-November. The Florida Belle variety won additional favor with growers and buyers because it carries its crop high on the plant and was free of soil rot.

Powdery mildew (Erysiphe polygoni) was observed to have affected 2 or 3 percent of the plants in two fields on the East Coast during January. In February it had increased considerably, affecting the lower leaves of approximately 100 percent of the plants in some fields. In March, powdery mildew was not observed to be serious.

Rust (Uromyces phaseoli var. typica) was observed in trace amounts on the East Coast and in the Everglades during February and in slight amounts during March and April.

Anthracnose (Colletotrichum lindemuthianum) was observed in trace amounts in one field in southern Palm Beach County during February.

CABBAGE Black rot (Phytomonas [Xanthomonas] campestris) was unusually prevalent this year. None of the seed used had been treated with hot water and wide variation was noted in amount of disease between different stocks of seed. The disease appeared in November and became more serious in December, when one grower reported a 50 percent loss in a field in which mature heads were affected. The disease was extremely destructive in January, one grower being known to have suffered a total loss on more than 300 acres. In February it was much less prevalent, being observed from time to time but not causing significant loss.

Downy mildew (Peronospora parasitica) was first observed November 21 at which time it was prevalent and destructive to seedling cabbage and broccoli. It was not observed to be significantly destructive later in the season.

Black leaf spot (Alternaria circinans) was observed in a small planting in St. Lucie County during April.

CARROT Mosaic (virus) was observed affecting 90 percent of the plants in one field in April.

Dodder (Cuscuta spp.), uncommon in the Everglades, was found affecting a good portion of two rows, growing on carrots and purslane, in April.

CELERY Damping-off (Rhizoctonia spp.). Losses from damping-off in the Everglades area were negligible this year, owing to widespread and efficient use of wettable Spergon sprays at intervals of four to seven days during the early period of growth in the seed bed, although the weather for the period (July-October) was particularly favorable for the development of the disease, which in other years has caused up to 50 percent loss of plants.

Early blight (Cercospora apii) was quite destructive early in the season when rains and labor difficulties made it difficult to start spraying as soon as desirable and to maintain a proper spraying schedule. Early blight was prevalent throughout the season, but where plantings were carefully sprayed with Bordeaux or Dithane-zinc-lime, no losses resulted. The heavy rains of March 14-18 severely damaged many celery fields and early blight became very severe on these fields. None of the fungicides were fully effective protectants under these conditions.

Bacterial blight (Pseudomonas apii) was seen for the first time in a few celery seed beds during September, but made no progress after one or two applications of Bordeaux mixture or other copper fungicides.

Pink rot (Sclerotinia sclerotiorum) was found in one field causing a loss of less than 1 percent. This is the first time its presence has been confirmed in this area.

Mosaic (virus) appeared during November and in two fields was observed to affect 11 and 25 percent of the plants respectively. It increased as the crop approached maturity, and counts showed as many as 60 percent of the plants near woody borders and ditch banks to be infected. Aphids were numerous on celery and weeds. Actual losses due to stunting of the plants and discoloration of the petioles were less than 1 percent of the harvested crop. In February, mosaic was observed to be affecting up to 100 percent of the plants in small areas, usually near borders of fields in proximity to weeds. One grower was losing 7 percent of the plants in his field. Most losses were much lower. In March losses of 25 percent were observed for a distance of 100-150 feet from the borders of fields, but only 2 percent further into the fields.

Pencil stripe (cause undetermined), which is characterized by a rusty brown stippling along the vascular strands of the petiole, appeared in moderate amount in two fields in November. It was observed to be affecting 7 percent of the plants in two fields near Zellwood (Orange

County) in December. These fields had been treated with 15 pounds per acre of borax. In April pencil stripe was found, along with the crack-stem symptom of boron deficiency, on 75 percent of the plants on 140 acres of new muck land that had received no boron.

Boron deficiency. Very severe symptoms of boron deficiency appeared on 75 percent of the plants on 140 acres of new muck that had received no boron. Several spray applications of borax over a period of one month to such celery, with extremely brittle and cracked stems, resulted in the production of a marketable crop.

Brown root rot (cause undetermined) was very prevalent in seed beds in December and in severe cases resulted in yellowing and stunting of the plants.

CUCUMBER Downy mildew (Pseudoperonospora cubensis) was very destructive to cucumbers on the East Coast in December, January, and February, resulting in some fields being plowed under before picking.

Mosaic (virus) was observed in trace amounts.

EGGPLANT Phomopsis blight (Phomopsis vexans), appears to be the limiting factor in eggplant production in the Coastal areas. Leaf spot and petiole lesions with only a trace of fruit rot appeared in September and October. Fruit rot and collar rot (resulting in the plants being broken off by the wind) had become very severe by December, causing many fields to be abandoned.

Mosaic (virus) was observed in trace amounts.

Wilt (cause undetermined) was observed to cause the death by severe wilting of 50 percent of the plants in one half-acre field.

ESCAROLE Hollow heart (cause undetermined). This disease is characterized by a brown discoloration and necrosis resulting in the main roots becoming hollow from the crown downward for some distance. When this occurs the heart leaves fail to develop and the plant is quite flat. Three attempts to isolate fungi from necrotic areas have resulted in failure.

Leaf spot (Alternaria spp.) was reported as quite destructive to two plantings in February.

Bacterial leaf spot. A bacterial leaf spot resulting in a watery soft rot was observed on this crop early in November.

PEA Pod rot (Rhizoctonia spp.) affected two-thirds of a 1200-hamper crop of Little Marvel peas grown near Port Mayaca (Martin County) in January. The grower was forced to sell these for the

cost of harvesting (50 cents) while good peas were selling at $4.60 per hamper. Soil contact and weedy fields were considered contributing factors in the development of this condition.

Powdery mildew (Erysiphe polygoni) was noted on two or three plantings on the East Coast in February, being especially severe on older plantings. This disease was also observed moderately affecting a planting of black-eye peas in St. Lucie County in April.

PEPPERS Cercospora spot (Cercospora capsici) was observed early in the fall to affect 100 percent of the plants in one field on the East Coast, both as leaf spot and stem lesions severe enough to cause breakage in some cases. It occurred in most plantings throughout the season but caused no serious losses except where control measures were lax.

Bacterial blight (Xanthomonas vesicatoria) was observed in most plantings both in the Everglades and on the Coast throughout the season. It caused some defoliation in scattered plantings but, in general, fruit spotting was not severe and no significant losses were sustained. Seed treatment is not generally practised for the control of this disease.

Mosaic (virus) was the most serious disease of peppers this season both in the Everglades and on the Coast. It was observed to have affected 1 percent and 10 percent, respectively, of the plants in two fields in December. In January the disease had increased to 20 percent infection and local spread was observed. Aphids were very abundant on the peppers. In February mosaic had reached epiphytotic proportions in coastal Broward County, with 100 percent field infection not uncommon, resulting in the abandonment of many fields and great reduction of yield in others. Average field infection was 40-60 percent. Several Everglades fields were infected to the extent of 50-95 percent. Heavy infections continued to be observed throughout the season.

Pink joint (Sclerotinia sclerotiorum) was observed in three fields in Broward County, the most serious infection resulting in a 3-4 percent loss of plants. This disease was not observed in Palm Beach County.

Early blight (Alternaria solani) appeared in scattered fields during February and March causing 1-2 percent loss of fruit in February.

POTATO Seed-piece rot (Fusarium spp. and various bacteria). Several carloads of certified seed potatoes from North and South Dakota arrived in very poor condition due to the development of Fusarium and bacterial rots on route.

Early blight (Alternaria solani) appeared on the older plantings late in November. Well sprayed fields were nearly free of the disease but control was poor in airplane-dusted fields. Early blight caused no

serious losses either in the fall or spring crops.

Late blight (Phytophthora infestans) first appeared November 28 and had been found in three plantings by the end of the month. It developed considerably during December and had killed unsprayed or poorly sprayed potatoes by December 15. Well sprayed fields remained green two to three weeks after the last application of Dithane or Copper A. Some late blight tuber rot was observed following rains late in the month. Yield reductions up to 33 percent have been noted. Principal losses occurred in fields that were not killed by the December 1 frost and not sprayed after December 15. Clean tubers were harvested from frosted fields and where spraying continued until the crop was harvested. In the spring crop planted in February, late blight developed after the rains of March 14-18. Labor trouble, insufficient equipment, and the weather combined to make application of the necessary control sprays difficult. A few fields were severely blighted by month's end. Applications of sprays, however, held the disease in check and of the 3500 acres of potatoes in the Everglades, only a small percentage was lost to late blight.

Stem rot (Rhizoctonia solani). A small percentage of the plants in all Everglades fields were affected by Rhizoctonia, which caused stems to rot after the crop was hilled.

Scab (Actinomyces scabies) was less prevalent than in most years. The Irish Cobbler variety was severely affected in the Station variety trials, while Triumph and Pontiac were only slightly affected, and the Sebago variety was quite clean.

SQUASH Mosaic (virus) was not serious in fall-planted squash on the Coast but became progressively so in the Everglades with infections of up to 92 percent in some fields. In the Spring crop it became serious in both areas, resulting in the abandonment of some fields on the Coast.

Blossom-end rot (cause undetermined). Squash on the Coast were observed in December to be affected in amounts of a trace to 20 percent by a blossom-end fruit rot which progressively envelops the entire fruit. The disease became more serious in January, and was present throughout the winter.

Root-knot (Nematodes). One field of squash on the East Coast was observed to be 100 percent affected by nematodes in January. This field was planted to okra, a very susceptible crop, last year. The operator estimated a 35-40 percent reduction in yield of squash due to root-knot.

Powdery mildew (Erysiphe cichoracearum) appeared in a few older plantings on the East Coast in February. Infection was heavy on older

leaves and stems in a few fields.

TOMATO Fusarium wilt (Fusarium oxysporum f. lycopersici). This disease was found in 30-40 percent of the plants in two fields in the coastal area in the early fall, accompanied by damage due to excessive moisture. Both fields were plowed up just as the plants had reached the flowering stage. Wilt was found lightly affecting one field on the Coast in December and was affecting 3-5 percent of the plants in a few fields in March.

Bacterial spot (Xanthomonas vesicatoria) was found widely distributed as a leaf spot and fruit "scab" in fields on the Coast in December.

Late blight (Phytophthora infestans) appeared on a few tomatoes at the Experiment Station about December 15 but made little advance. The disease appeared in epiphytotic proportions in 35,000 acres of tomatoes in Broward County in late January and became generally distributed in 1,000 acres of tomatoes in eastern Palm Beach County by February 6. The weather during February was not generally conducive to spread of the blight, so that new growth replaced the blighted leaves and the fruit from unsprayed fields was received at the packing houses in equally good condition as that from protected fields. Reduction in yields of about 50 percent were estimated, with blight as the chief contributing factor. The disease caused abandonment of many newly transplanted fields in Martin County and Palm Beach County. There has probably been a greater loss of mature fields in Martin than in Palm Beach County. Dithane-zinc-lime spray and Copper A spray and dust (6 percent metallic copper) have been used extensively for control. Fungicidal applications have not been regarded as satisfactory in controlling the disease but maintenance of a regular spraying schedule has proved profitable in keeping the fruit relatively free and satisfactory for green shipment.

Gray leaf spot (Stemphylium solani) has proved a serious defoliant in many fields on the East Coast throughout the growing season, affecting the plants with a stem and petiole infection as well as a leaf spot. This disease was considered second only to late blight in seriousness in some areas.

Early blight (Alternaria solani) appeared early in the fall and was generally present throughout the season but was considered of minor importance.

Mosaic (virus) was noted affecting as high as 10 percent of the plants in some fields in eastern Broward and Palm Beach Counties but was less serious in the Everglades. One field was conservatively estimated to be 60 percent infected on the East Coast in March. Individual rows were uniformly infected, suggesting spread by the sprayer, which had been through the field several times in an attempt to control a light

infection of late blight.

Stem rot (Sclerotinia sclerotiorum) was found in trace amounts in Broward County.

Leaf mold (Cladosporium fulvum) was found in light infection in one field on the Coast during the last week of March and in a few fields during April.

Blossom-end rot (physiogenic) was noted in a few East Coast fields during March. Most serious damage noted was 10 percent in one field.

CORN Leaf blight (Helminthosporium turcicum) became very prevalent in a large field of hybrid sweet corn in April, although it did not appear on other corn in the area.

OATS Stem rust (Puccinia graminis var. avenae). A severe 100 percent infection of the plants in a field on the East Coast was observed in April.

ALFALFA Rust (Uromyces medicaginis) was found lightly affecting about 40 percent of the plants in one field in coastal Palm Beach County during April.

CLOVER Sooty blotch (Polythrincium trifolii) [Cymadothea trifolii] was seen as a very light infection on 8-10 percent of the plants in a field of White Dutch clover on the East Coast in April.

LESPEDEZA Powdery mildew (Microsphaera diffusa) was found moderately affecting the plants in a mixed field of common and Korean lespedeza on the East Coast during April.

LILY Mosaic (virus) appeared on about 75 percent of the Easter lilies in two small fields in April.

WEEDS Watery soft rot (Sclerotinia sclerotiorum) was found generally affecting the common ragweed and milkweed in old bean fields in Broward County where the disease had been present on the beans at an earlier date.

Mosaics (virus) occurred on Portulaca and Commelina near celery fields.

EVERGLADES EXPERIMENT STATION, BELLE GLADE, FLORIDA
May 10, 1946

## ALFALFA AND CLOVER DISEASES IN VIRGINIA

S. B. Fenne, C. L. Lefebvre, R. G. Henderson, T. J. Smith

During the week of April 15, a disease survey was made of alfalfa and clover in the counties of Campbell, Amelia, Nottoway, James City, Caroline, Fauquier, and Orange.

Blackstem (Ascochyta imperfecta) was found in practically every alfalfa field visited, although to a lesser extent than was observed in the same area last year. Blackstem caused considerable injury in some cases where the leaf spot phase had caused partial defoliation and the stem lesions had killed the young, tender stems. Much crown injury was observed, which apparently had been caused by this Ascochyta.

In the eastern part of the State, especially in Amelia, Nottoway, James City, and Caroline Counties, many fields of alfalfa were observed, where severe injury had been caused by stem rot (Sclerotinia trifoliorum). In some fields, 30 to 50 percent of the plants had been killed by this disease. On the Experiment Station plots at Williamsburg, certain varieties of alfalfa appeared to be rather tolerant to stem rot, but several of the popular varieties had suffered over 60 percent kill on several plots. An abundance of sclerotia were found in the soil around affected plants, and some were found attached to the roots at a depth of 4 inches. The disease was observed also on red, alsike, and crimson clover, and on vetch and Austrian winter peas. Stem rot seemed to be particularly injurious in the lighter, sandy soils of Eastern Virginia, and appeared to be rather rare in the heavy, clay soils of North Virginia and in the Shenandoah Valley. However, stem rot with abundant sclerotia was found on the experimental plots at Blacksburg.

Downy mildew (Peronospora trifoliorum) was observed rather generally distributed in new stands of alfalfa, and, in a few cases, caused the loss of some of the top leaves. Alfalfa leaf spot (Pseudopeziza medicaginis) and [yellow] leaf blotch (Pyrenopeziza medicaginis) were observed generally, but caused only minor injuries where the plants were in a general vigorous condition. Severe root knot (Heterodera marioni) was found in one field where red clover followed cropping with tobacco for several years. Powdery mildew (Erysiphe polygoni) of red clover was found in most clover fields visited.

Heaving of the plants as a result of freezing was observed in one 4-year-old alfalfa stand in Fauquier County. In the lower and wetter parts of the field, large plants with roots an inch or more in diameter were lifted out of the soil, and some of the larger tap roots were split. In some portions of the field, as high as 30 percent of the plants had been killed.

At the Field Experiment Stations at Charlotte C. H., Williamsburg, Bowling Green, and Orange, strains of alfalfa and red clover were observed that were highly resistant to the root-disease complex which caused severe injury to other varieties grown in adjacent plots. A Virginia selection of alfalfa was far superior in this respect to all others grown. It showed less injury from stem rot and a thriftier appearance than the alfalfa in adjacent plots. The strains of Virginia Northern Neck red clover appeared to be far superior to red clovers from other sources. The stands were thicker and the growth more vigorous.

VIRGINIA POLYTECHNIC INSTITUTE AND U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, DIVISION OF FORAGE CROPS AND DISEASES.

## RUSTS OF SMALL GRAINS IN TEXAS

I. M. Atkins

April 15 - In the Denton areas leaf rust [Puccinia rubigo-vera var. tritici] of wheat has spread rapidly with heavy infection now present on susceptible varieties. The varieties Denton, Clarkan, and Comanche seem to have abnormally high infection this season. Pawnee has some leaf rust but Westar is entirely free from rust this season in contrast to its high infection last year. Another interesting feature, not observed in such contrast before, is the very high susceptibility of Wichita. It has much higher infection and is being damaged much more than Early Blackhull. The Hope-Mediterranean hybrids are showing good resistance. The South American varieties and their hybrids, especially those with Wichita, are very resistant and indicate promise at this time. The experimental wheat is in good condition and promises a good crop.

Crown rust [Puccinia coronata] was found in experimental oats on the station on April 12. This is earlier than normal but probably is to be expected after the mild winter. Fall-sown experimental oats are very good, which is encouraging after about 5 years of near or complete failures with oats in this section. Commercial fields of oats vary greatly. A number of fields have been observed fully headed and very thin. Other fields appear to be of promise.

May 13 - At Denton weather conditions during the first half of May have been favorable for grain. Temperatures have been below normal in contrast to the above normal temperatures, which have prevailed since the first of the year. Maximum temperature was 88° F. On 7 days the maximum has been below 80 ° F. Minimum temperature was 43°, with minimum temperatures below 60° F. on 11 days. Only one clear day was

recorded. Traces of rain were received on 4 days and .64 inch yesterday. Heavy dews have occurred every day that rain was not recorded.

Small grains have made good progress and many early varieties are nearing maturity. The drill plats of barley were harvested on May 8, which is two weeks earlier than normal. Frazier oats is mature and Early Blackhull wheat will be mature in a few days. A few fields of oats on farms have been harvested. Harvest of Early Blackhull wheat, where cut with a binder, will probably start this week if weather permits.

Leaf rust of wheat continues severe with leaves of susceptible varieties now largely destroyed and drying up. Stem rust [Puccinia graminis] has spread fairly rapidly from centers on the station. Stem rust of oats has just appeared but crown rust has spread rapidly and can be found on all susceptible varieties. There is considerable leaf rust [P. anomala] of barley.

At Greenville, April 30, leaf rust of wheat, oats, and barley were present but no stem rust was observed.

At Iowa Park and Chillicothe, May 7, a moderate amount of leaf rust on wheat was seen but no other rusts were observed.

DIVISION OF CEREAL CROPS AND DISEASES

## AZALEA FLOWER SPOT APPEARS IN MARYLAND

By Philip Brierley

Azalea flower spot, caused by Ovulinia azaleae Weiss, has long been known from the Coastal Plain, from Texas to North Carolina, and has appeared in California. No previous report of its occurrence north of Wilmington, North Carolina, is known to us, and the question is frequently raised as to whether it is capable of establishing itself farther north.

In 1945 we received sclerotia typical of Ovulinia that had been collected in a private garden at Takoma Park, Maryland. Again on May 3, 1946, the writer's attention was brought to primary lesions and early stages of "limp blight" appearing in azalea flowers in the same garden. Conidia of Ovulinia were abundant on the latter. These collections of sclerotia and of conidia have been filed with the Division of Mycology and Plant Disease Survey.

Azaleas have been assembled in the garden in question from many sources, but no new plants have been added during the past 3 years.

The origin of the disease cannot be traced, but it is evident that the causal fungus can maintain itself in Maryland. It can be transported as mycelium or conidia in or on flowering azaleas, or as sclerotia in the surface soil about dormant plants. This garden has now been thoroughly sprayed by the owner in an effort to prevent local spread of the disease.

DIVISION OF FRUIT AND VEGETABLE CROPS AND DISEASES.

## OBSERVATIONS ON AZALEA FLOWER SPOT IN MARYLAND

Freeman Weiss

Examination on May 8 of several gardens at Takoma Park showed a very light infection, apparently communicated by bumblebees, in a large planting of mixed varieties of azaleas about 100 yards distant from the original outbreak, but none at that time in 3 contiguous azalea gardens some 300 yards away. Stripping of infected flowers was assiduously practised in the first garden mentioned above, and several applications of spray were made.

In an examination made June 5 only one flower bearing a mature sclerotium, and several bearing abortive sclerotia, could be found. In the original infested garden numerous flowers bearing mature sclerotia were present on the bushes, and some had fallen to the ground. In addition to the large-flowered varieties such as Rhododendron mucronatum and R. kaempferi derivatives, several of the small-flowered Kurume varieties (R. obtusum), such as Snow, Pink Pearl, and Bridesmaid, bore small but apparently normal sclerotia. A few infected flowers also were found in one of the 3 gardens in which no infection was evident on May 8.

The virtual ending of the season of azalea bloom will doubtless prevent further spread, but the situation will require careful watching and remedial action next year. Further search for the disease in the suburbs of Woodridge (northeast Washington) and Bethesda (northwest) has not disclosed its presence.

DIVISION OF MYCOLOGY AND DISEASE SURVEY.

## BRIEF NOTES ON PLANT DISEASES

### RUST ON LETTUCE IN NEW YORK

By Charles Chupp

A few spots of the aecial stage of Puccinia extensicola hieraciata (Schw.) Arthur were found on the lower surface of Great Lakes lettuce leaves, June 7, on a farm in Niagara County near Lockport, New York.

CORNELL UNIVERSITY, ITHACA, NEW YORK.
June 10, 1946

### SOUR CHERRY YELLOWS IN NORTH CAROLINA

By. C. N. Clayton

A sour cherry tree in the Brushy Mountains near Boomer, North Carolina, was exhibiting typical leaf symptoms of cherry yellows (virus) on May 28, 1946. Approximately 10 percent of the leaves had recently dropped from the tree. Sour cherry sprouts from the roots of the tree had some leaves with symptoms of yellows.

About a dozen yellow leaves that were typical of those on yellows-infected trees were found on this tree on May 15 which was about 6 weeks after full-bloom. On this date the cherries were almost ripe. Harvest was about May 20. Thus, the wave of defoliation from yellows came during and soon after harvest rather than prior to harvest as occurs in affected trees in northern cherry-growing regions.

The history of this lone sour cherry tree, believed to be of the Montmorency variety, may be of interest. It was located in the middle of an apple orchard, having been planted there about 20 years ago. The tree had been obtained as a sprout from the roots of a cherry tree growing about 1/2 mile away which previously had been taken nearly 50 years ago as a sprout from a cherry tree on a neighbor's farm a few miles away. When, where and how did the tree become infected?

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

# OBSERVATIONS ON COFFEE ROOT ROT IN EL SALVADOR

Frederick L. Wellman

El Salvador is the smallest, most densely populated, and most intensively cultivated country on the North and South American continents. It is almost wholly dependent on coffee (Arabian and Bourbon varieties) for its exports, since between 80 and 90 percent of them consist of this product. It is a one export crop country, and anything that limits coffee culture is of the utmost importance to its inhabitants.

Coffee trees have numerous diseases, most of which can be sufficiently controlled or tolerated in El Salvador by varying cultural methods. These make up an art that has been developed to a high degree. Coffee is grown here under shade trees, which are such that regulation of shade intensity and in some cases the addition of fertilizer, are the means used to check foliage diseases. Root rots are, however, a different matter, and the problem has been of concern for probably 20 years at least in El Salvador. Much credit is due the efforts of the men working in the Servicio Técnico, de Asociación Cafetalera de El Salvador. Specialists were invited in and technicians were hired, but the difficulties under which these men had to work,the troubles they had with securing adequate technical equipment, inconveniences experienced due to war conditions, breaks in the continuity of their labors, etc., did not result in research situations from which these men (Choussy, Uphof, Stern, Alvarado, and others), could obtain the most definitive conclusions. Results of their work have been published in past volumes of the monthly journal "El Café de El Salvador", Revista de la Asociación Cafetalera de El Salvador, but it is not the purpose of this report to review them here.

## Symptoms of Root Rot

For the past three years certain trees have been watched and studied in three plantations. The most striking symptom is that seen on a large, apparently good tree that simply wilts and dies within a short space of time. This wilting occurs during the wet season and is often so rapid that few leaves are dropped. Leaves droop, are yellowish green with bronze and tan markings along veins or midrib, and soon shrivel. After the dry season is well advanced, this typical wilting and collapse does not occur in the drier locations. On trees in dry soil the leaves may yellow and drop rapidly except for a few remaining at the tips of the top branches. Fruits do not drop on account of the oncoming death of a tree, but they mature poorly, and if it is still raining, or the dews are heavy, they show many infections from Cercospora coffeicola Berk. & Cke., Colletotrichum coffeanum Noack, as well as saprophytic fungi.

Study shows that certain early tree symptoms, before collapse, are

noticeable for more than a year before the tree finally succumbs. The leaves are somewhat narrower and of a lighter green on many diseased trees than on comparable healthy plants. The younger leaves tend to "cup" upwards, and are less "ruffled" than those on healthy trees. In general the tree shows other evidence of reduced vigor, and dieback of side branches will often be seen. Some leaves may drop from the fruit-bearing wood, and in many cases drooping of these bearing branches becomes quite pronounced in a year's time.

When the roots of a diseased tree are exposed, it will be seen that many of the fibrous roots have disappeared. The larger roots, whether lateral anchor, or tap roots, often show decay that has partly consumed them. In some instances there may be white fungal growth over these roots; in some, red, or dark- or light-colored rhizomorphs are found; in some the roots decay leaving shredded remains; and in some all but the fibrous roots are fairly intact although they are dead. Destruction of the cortex on diseased roots is a common symptom, and instances can be seen where infection of a small fibrous root has travelled back to the larger root with the fibrous root's attachment as its center.

I have not yet been able to come to a definite conclusion about the cause of the root rot. Years ago the disease was given the popular name "Podredumbre negrade la raiz" (black root rot). To some this has suggested decay by Rosellinia, but in my observations of several thousand roots of diseased trees I have seen only 4 examples that were certainly connected with a Rosellinia. Isolation and cultural work, combined with note taking and materials collected for identification, and finally inoculation studies are being pursued to obtain knowledge of what is causing the root rot. A tentative judgment is that several organisms are involved.

## Economic Importance of the Disease

A regular part of the coffee finca program is replanting. Percentage of replantings varies, but on a yearly basis it is usually from 3 to 12, depending on conditions. I discussed coffee replanting costs with a few growers and concluded that at present it costs about: 2 cents to produce a coffee seedling ready for transplanting from the nursery; 4 cents to dig out and remove old trees and prepare the hole for replanting; and 2 to 6 cents to dig, transport, and plant the nursery trees in the field. Trees start bearing in 3 to 4 years. If they escape root rot they reach peak production in 7 to 15 years and maintain it for about 10 more. After this, decline is expected to set in and replanting is then in order.

Taking into account costs of production, transplanting, care in the plantation, and the value of the crops they produce, a single coffee tree can be of considerable worth. Owners give various figures be-

tween 16 and 40 dollars per tree when it is full grown. Many good plantations have from 590 to 765 trees an acre. Whatever the exact average value for a tree, it can be seen that removal of trees in full bearing, because of root rot, becomes a serious economic loss, especially if replanting results in repeated failures, as has been observed in numerous cases.

One group of operators gave me figures of trees actually dug out because of root rot, from January to November, 1945. Nine plantations were represented in this group, averaging a little over 88 acres each; and an average of 1,262 trees had been removed from each plantation in the time specified. In subsequent visits to some of these plantations from which these data had come I found many more trees that had died since the last figures had been recorded.

## Field Spread in Diseased Areas

Diseased trees occur at first singly, or in a small group, making a center of infection. Other trees then succumb around this center, or along the rows of trees in which the disease first appeared.

During the months of October and November, at the close of the rainy season in 1945, I visited 9 plantations and saw 19 diseased areas which I studied for method of spread. Besides discussing the areas with owners and workers I made observations, counts, and diagrams. The results of these data are represented in Table 1. Ages of areas were obtained by talking with owners who had kept records of when they were first discovered, and can be considered as reasonably exact, except for areas 1, 2, 15, 16 and 17, which may be a year or two older or younger than the age indicated.

The following deductions may be made from these data: The numbers of diseased trees in an affected area do not necessarily indicate the age of such an area. No. 11, for example, was half a year old and included 22 diseased trees, while areas 8, 9, 10 and 13 that were at most a few months older had only 1 to 5 trees involved. Areas 3 and 6 were each 4 years old and had 29 and 28 diseased trees in them respectively. On the other hand, areas 15 and 16, considered to be 8 and 5 years old, had 28 and 23 diseased trees respectively, and area 17 judged to be 5 years old, had 28 diseased trees. Steepness of slope may have something to do with rapidity of spread of the disease, but available data are not sufficient for conclusions. Steepness of slope may be a complicating factor in study of age of diseased area in relation to the number of diseased trees found. On the other hand, the oldest area visited was No. 2, 20 years old with 45 diseased trees, on a steep slope. But the largest number of diseased trees, 64, was found in area 1, about 6 years old on a very gentle slope. It was found that, in general, spread occurs from a center outwards, in all directions in moderately level soil, along rows

Table 1. Data from areas of diseased trees attacked by coffee root rot in El Salvador.

| Plantation | Area of disease: No. | Age (years) | Slope | Diseased trees (Number) | Shape of area | Apparent direction of spread |
|---|---|---|---|---|---|---|
| A | 1 | 6 | Very gentle | 64 | Circular | All directions |
| B | 2 | 20 | Steep | 45 | Elliptical | All directions and along contour rows |
| B | 3 | 4 | Very steep | 29 | " | Downward and along contour rows |
| C | 4 | 5 | " " | 31 | Circular | All directions |
| C | 5 | 1 | " " | 5 | Linear | Down slope |
| C | 6 | 4 | " " | 28 | Elliptical | Downward and along contour rows |
| C | 7 | 3 | " " | 32 | " | " " " |
| D | 8 | 1 | Level | 5 | Circular | All directions |
| D | 9 | 1 | Very steep | 1 | --- | --- |
| D | 10 | 1 | Steep | 2 | --- | --- |
| E | 11 | 6 months | Level | 22 | Circular | All directions |
| E | 12 | 1 yr. 7 mo. | Very steep | 18 | Elliptical | Along rows on contour |
| D | 13 | 1 | Steep | 4 | Circular | All directions |
| D | 14 | 10 | Level | 41 | " | " " |
| F | 15 | 8 | " | 28 | Elliptical | Along rows |
| F | 16 | 8 | " | 23 | Circular | All directions |
| G | 17 | 5 | Steep | 28 | Elliptical | Downward and along contour rows |
| A | 18 | - | Level | 19 | Circular | All directions |
| A | 19 | - | Gentle | 25 | " | " " |

that are planted on the contour of steep slopes, and downwards from row to row on steep slopes.

Another point is notable from these observations: the mode of spread is fairly typical of an infectious organism in the soil. While coffee root rot is considered by many to be of fungal causation, this is by no means a generally accepted opinion in El Salvador. There are good indications that there may be soil relationships, and some believe that the lack of nutrients or of a minor element is at the bottom of the trouble. However, all these matters still remain to be more fully studied in El Salvador, and this work is in progress.

## Methods Used By Growers Attempting To Control Root Rot

During the past years, growers have attempted to get at the question of root rot causation through their control methods. Diseased plants were removed in some plantations and large holes were then excavated and filled with new soil from disease-free areas. Seedlings that I have seen planted in the new soil lived for a while, but sooner or later succumbed. In some instances they appeared to have maintained life for about three years after transplanting. In other cases they died before a year had elapsed.

Some growers scattered lime or calcium carbide in holes dug after diseased plants had been removed, and replanted using leaf mold and top soil with some fertilizer added. The history of replants treated in this way was the same as noted before. They lived at most until they they had produced their first crop of fruit.

A number of growers have, in the past, trenched around root rot rot areas. They considered that rapid spread of the disease was somewhat checked in its progress by this treatment, but that it finally "jumped" the trench and continued its progress. In a few instances root rot areas seemed to have been stopped in their progress in one direction by a roadway in the path of the spread. In one case, however, I saw an area which had apparently extended across a roadway in two places.

In some plantations soil disinfection has been attempted by building fires in old holes, or by burning with torches. These treatments were reported by some of the growers as of no special value, since replanted trees in burned soil succumbed as rapidly as nearby replants where they had simply dug out the diseased trees and replanted with healthy seedlings which died in a short while.

## Apparent Disease Tolerance or Resistance to Root Rot

I visited a few plantations where replanted disease areas were close to the residences. Hit-and-miss treatments of all kinds had been attempted in some of these, and in some advantage was taken of the open spaces to plant other varieties of coffee than the Arabian or Bourbon that had died. All kinds of variants of Arabian and Bourbon, and crosses between them, seemed as susceptible to root rot in the soil as did their parents. However, the Robusta variety appeared at least highly tolerant. Indeed, I saw no instance of a Robusta plant being killed by root rot, although I was told that an occasional plant had died for some reason.

The admitted inaccuracies with regard to the age of the diseased areas and histories of planted trees have not permitted reliable ob-

servations on apparent resistance of the Robusta variety to root rot. However, I visited one place in June, 1943, where I saw a Robusta tree said to be 8 years old and growing for that length of time in an area long abandoned for Arabian production on account of root rot. A few Arabian and Bourbon seedlings had been planted around this tree, but they were dead, and still in the ground when I visited the area. I was told they had collapsed in less than six months after transplanting. In October of the next year, I saw seven similar instances in two other plantations, and in November, 1945, another case in another plantation. I found also a planter and a friend who had been experimenting with grafting Arabian onto Robusta rootstocks. Out of 60 such grafted trees, a number had been planted in old disease-abandoned areas, and after three years were still alive and bearing heavily. Arabian trees, planted near the grafted trees three years ago, had died from root rot.

CENTRO NACIONAL DE AGRONOMÍA DE EL SALVADOR, IN COOPERATION WITH OFFICE OF FOREIGN AGRICULTURAL RELATIONS, UNITED STATES DEPARTMENT OF AGRICULTURE.

# THE LOSS FROM COTTON WILT AND THE TEMPO OF WILT DEVELOPMENT: A STUDY OF NEW USES FOR OLD DATA

K. Starr Chester

## Introduction

A reasonably accurate knowledge of the amounts of loss caused by the various diseases of our principal crops is essential to productive and economical planning of research, extension, regulatory, and teaching programs in plant pathology. We are witnessing many changes in the pattern of American agriculture resulting in attempts to grow crops where they have not been grown before; many disease hazards are involved, and, lacking concrete information on the amounts of crop loss that result when given crops are subjected to given intensities of their several diseases, we are unable to make the most effective contribution to the planning of these new enterprises.

The future of plant pathology itself depends, in large measure, on our ability to convince the administrators of research and extension funds of the impact of plant diseases on agriculture and the economic and social values to be obtained through their control. We cannot do this through academic generalities or rough estimates, unsupported by experimental determinations: we must know the degree of destructiveness of the diseases with which we work.[1]

The measurement of the losses resulting from plant disease can and should be an essential part in the comprehensive study of any disease. Nearly every disease control experiment or demonstration offers an opportunity to determine the amount of loss caused by the disease in absence of control measures. It is rare that experiments and demonstrations have been carried out with this in mind, but the possibility of many worthwhile contributions to the economics of plant disease is an attractive opportunity for future research, as one of the several phases of each detailed plant disease study and as a special area of research for a few pathologists who see in the economics of plant disease a profitable field for full-time activity.

Meanwhile our stockpile of specific information on the losses caused by plant diseases is low, apart from a few outstanding exceptions (e.g. wheat rusts; corn smut; root rot of cotton; certain virus diseases of tobacco, potato, tomato, and sugarcane; and forest tree decay). There is, however, a rich source of data from disease control experiments,

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[1] This theme is developed in detail in a paper, "The Measurement of Plant Disease Losses," to appear in a forthcoming number of Chronica Botanica.

variety tests, etc., which, when restudied from the point of view of measurement of plant disease loss, can yield valuable information on the amonts of loss.

It is the purpose of this article to illustrate such use of data, originally obtained with quite different objectives, the example being the extensive data obtained by Arkansas workers and others on the reaction of cotton varieties to Fusarium wilt and the effect of fertilizers in reducing wilt damage. These data shed valuable light both on the amount of loss due to wilt and on the tempo of wilt development as affected by variety, season, and soil. It is hoped that the results of this study may lead others to a reexamination of old data to the same end, and an invitation for informal cooperation is extended to those who may be interested in this phase of phytopathology, that, it is hoped, may pave the way for formal cooperative efforts toward providing a sounder basis for our estimation of crop disease losses.

## Types and Sources of Data: Method of Calculation

The cotton wilt data on which this study is based have come principally from the extensive studies of V. H. Young and his coworkers in Arkansas (1-7) with a few additional data from other sources. The calculation of the wilt-yield loss relationship from data on variety tests is based on 24 separate experiments, each being a test of several varieties in uniform soil, for each of which are given final wilt percentages and yields in pounds of seed cotton per acre or per experimental row. Each experiment was in a different location or year and usually involved cotton varieties somewhat different from those in other experiments. The comparison with the wilt-yield loss relationship from data on fertilizer tests is based on 52 separate experiments in each of which the cotton variety was constant and 2 to 11 fertilizer treatments were used, each experiment being in a different season or location from the others, with data on final wilt percentages and yields. The study of tempo of wilt development is based on the work of Young and his colleagues who have furnished data on wilt percentages for all varieties and fertilizer treatments tested on each of 3 to 8 successive dates in any given field and year.

In preparation of the wilt-loss graph the following procedure was used. In each experiment the variants were classified in 16 classes, from those exhibiting 0-5% (2.5%) wilt by 5% intervals to those with 55-60% (57.5%) wilt. In each experiment the yields of variants with 2.5% wilt were compared with those showing 7.5%, 12.5%, 17.5% ..... to the maximum wilt percentage observed. The yield differences were expressed as percentages of difference for each step in the wilt classification. These were all averaged, weighting the results for the number of variants in the member of each compared pair having the smallest number of variants in the groups, so that proportionately greater significance attached to comparisons having greater numbers of variants. When a

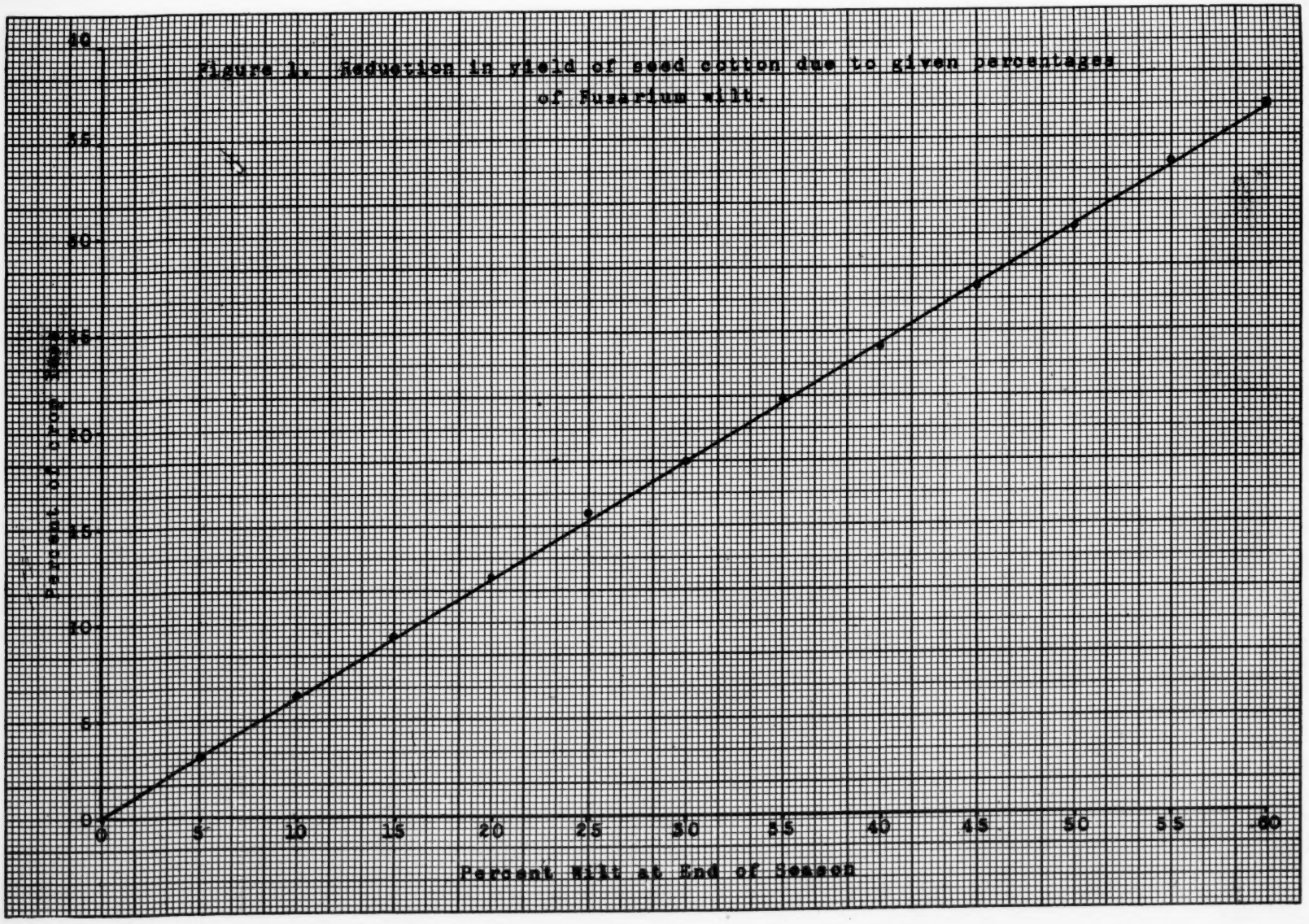



Figure 1. Reduction in yield of seed cotton due to given percentages of fusarium wilt.

comparison was made between wilt classes that were not adjacent (e.g. 2.5% wilt : 12.5%) the difference in yield, expressed as per cent was divided by the number of steps in the range (2 in this case), and the fraction of yield loss obtained was assigned to each class in the range, weighting for the number of variants involved, as before. This procedure gives a mean percentage of crop loss from wilt in advancing from any wilt percentage class to the next higher class, a series of increments of yield reduction corresponding to the classes of increasing wilt percentage. It is based on a summation of yield comparisons within single experiments to avoid the errors that would result whenever yields of different experimental fields are compared directly with one another.

## Loss from Wilt as Indicated by Variety Tests

The findings from all experiments in which yield reduction due to wilt is derived from variety comparisons on wilt-infested soil are summarized in the graph of Figure 1.

The suitability of this method of determining loss due to wilt is indicated by the very close fit of the experimentally determined points to a straight line. This shows that for every 5% increase in wilt percentage (determined at the end of the growing season) there is approximately a 3% yield reduction. Although wilt kills the plants the percentage of yield reduction is not equal to that of wilt because the wilted plants produce some cotton before dying and because of compensating effects of healthy plants adjacent to diseased ones. The loss in yield in this case is purely quantitative. Additional loss, not brought out by this study, occurs due to the fact that the lint from wilt-affected plants is lower in quality than that from normal plants (7) and to the greater relative cost of picking cotton from poor crops.

Several of the investigators who have worked with cotton wilt have suggested that increase in percentage of wilt is correlated with decrease in yield but only when the wilt incidence is 10% or greater (1, 2, 4). The analysis of a large body of data, as summarized in Figure 1, brings out the fact that there is 3% loss and 6% loss when the wilt frequency is 5% and 10% respectively. Losses of 3-6% may not be noticeable in the field and may not become apparent until extensive data are analyzed. But such losses do have economic significance, since it is the total of small yield factors, from many causes, that makes the difference between success and failure in farming.

It is recognized that this 5:3 relationship between wilt percentage and percentage yield reduction would not apply exactly to all locations, cotton varieties, and seasons, but it appears to represent a fair average of the loss sustained from the wilt disease when many fields, varieties, and seasons are used in the calculations. It is a better basis for appraising loss due to wilt than the speculations or

ungrounded estimates to which survey workers have been limited in the past, and it gives the possibility of arriving at a reasonable conclusion as to the amount of loss sustained in past years for which records of wilt prevalence alone are available.

## Loss from Wilt as Indicated by Fertilizer Tests

Application of certain fertilizers, particularly those containing potassium where this is deficient in the soil, aids in the control of Fusarium wilt of cotton and also contributes toward more normal plant growth and increased cotton yields. If the study of loss is based on a comparison of plots in soil of low fertility, showing high wilt percentages with plots with fertilized soil, showing lower wilt percentages, the loss in this case is not due to wilt alone but to the combination of wilt and poor plant nutrition. The loss percentages would be expected to be higher than those for wilt alone, and this was borne out by an analysis of the data from wilt-fertilizer experiments.

The analysis showed that when the two yield-depressing factors, wilt and low fertility (primarily low potassium) were acting concurrently, the percentage crop loss was approximately twice that due to wilt alone, up to 25 per cent wilt. At higher wilt percentages the combined loss was proportionately less than twice the loss due to wilt alone, until at 60 per cent wilt the loss from wilt and deficient soil was only 9 per cent higher (43%) than the loss from wilt alone (36%).

The data from fertilizer experiments are less suitable than those from variety tests for arriving at the degree of damage due to wilt, since the fertility factor cannot be readily dissociated from the wilt factor. They are helpful, however, in showing the extent of damage which may frequently result from the combined yield-depressing effect of these two factors which often are associated in cotton fields.

It is recognized that the yield-depressing effect of Fusarium wilt as analyzed here is based primarily on data from Arkansas and that somewhat different wilt-yield relationships might apply in other parts of the Cotton Belt. This point cannot be resolved further, at present, in view of the lack of comparable data from other regions.

## The Tempo of Cotton Wilt Development

A knowledge of the tempo of seasonal development of a plant disease, --whether it is accelerating, progressing at a steady rate, or decelerating--, is valuable in determining the outcome of the disease. Just as the experienced seaman can judge by signs that are unnoticed by the landlubber the course and rate of progress of a distant ship, so the crop disease survey worker can learn to discover the indications of the tempo of disease development.

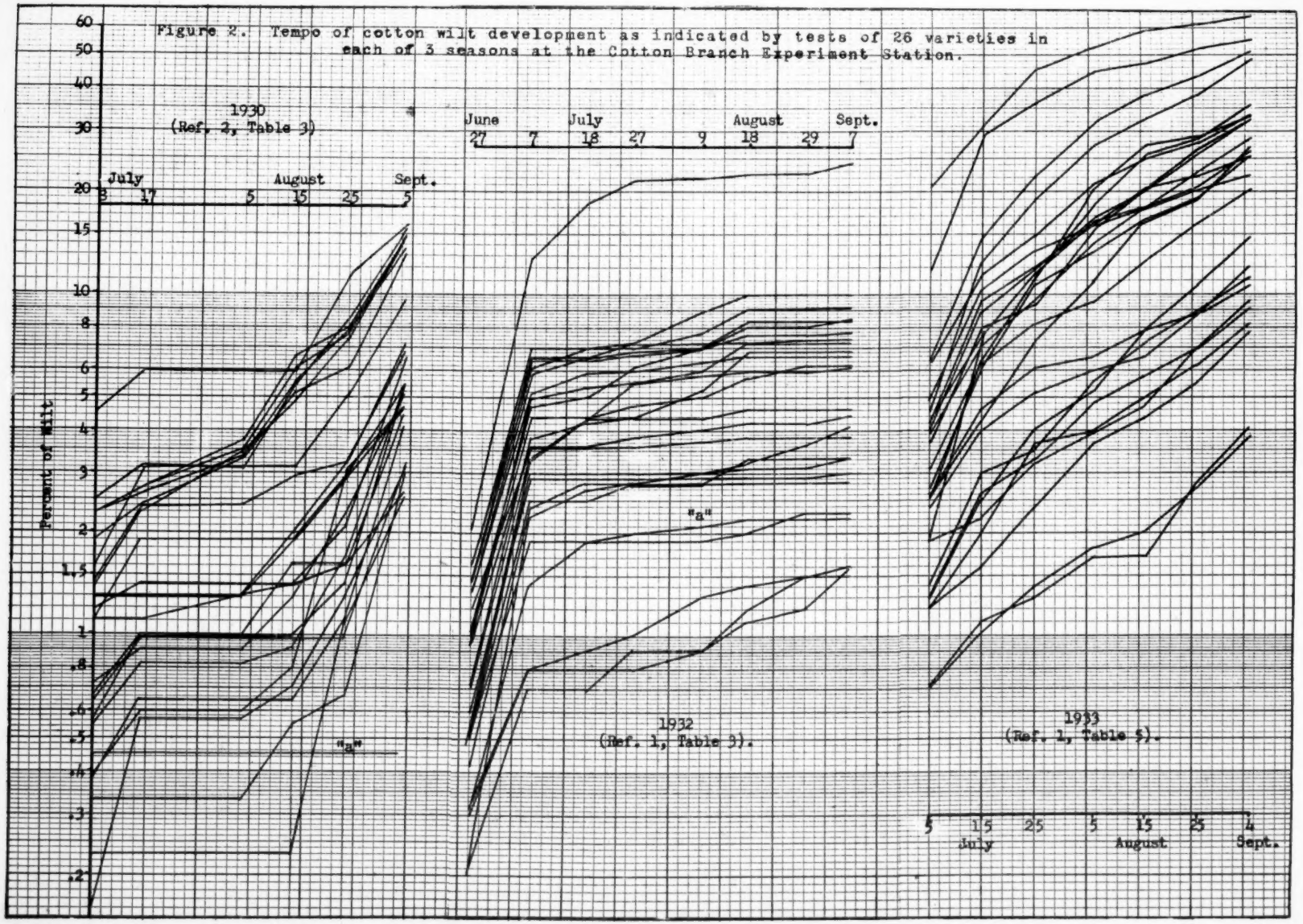


Figure 2. Tempo of cotton wilt development as indicated by tests of 26 varieties in each of 3 seasons at the Cotton Branch Experiment Station.
Percent Wilt
60
50
40
30
20
15
10
8
6
5
4
3
2
1.5
1
.8
.6
.5
.4
.3
.2
1930
(Ref. 2, Table 3)
July
3
17
August
5
15
25
Sept.
5
"a"
1932
(Ref. 1, Table 3).
June
27
July
7
18
27
August
9
18
29
Sept.
7
"a"
1933
(Ref. 1, Table 5).
5
15
25
July
5
15
25
August
4
Sept.

Study of the tempo of disease development requires frequent, periodic measurements of disease intensity during single growing seasons. The data on cotton wilt supplied by Young and his associates are admirably suited for this purpose as is illustrated in Figure 2.

The three experiments on which the graphs are based, variety tests at the Cotton Branch Experiment Station in 1930, 1932, and 1933, were selected from among many other similar experiments because in these the data are more extensive than in some of the other experiments, and because the curves demonstrate the results of marked seasonal differences in tempo of wilt development.

Other experiments might have been used to illustrate the uniformity of tempo of different cotton varieties in a given environment. The data for each year show this tempo for 26 cotton varieties ranging from highly resistant to highly susceptible to wilt. From the figure, several points are apparent.

It is seen that the semi-logarithmic coordinates used in plotting the data bring out the tempo to good advantage, much better than if an arithmetical ordinate had been used. This is in accordance with the tendency of many plant diseases to increase at a geometric rate as time advances by arithmetical intervals.

The tempo of wilt development for a large number of varieties in any one location and season is quite constant regardless of their resistance or susceptibility to wilt. Deviations from this regularity are minor and probably of doubtful significance. An exception, however, is seen in the graph of the variety indicated as "a" in the 1930 series. This variety (Arkansas 17) showed no change in wilt percentage throughout the period of observation whereas the other varieties exhibited first a rapid, then a slow, and finally a second rapid increase in tempo of wilt development. Such aberrant cases also appeared occasionally in the data for other seasons and locations and might indicate that the cotton varieties in question differ qualitatively in type of wilt response from all the other varieties tested. It is more likely, however, that this represents fortuitous escape from infection, particularly as the level of infection for such varieties is very low and hence the possibility of experimental error is high. In the 1932 tests ("a") the same variety, Arkansas 17, showed a tempo of wilt development that did not differ materially from that of the other varieties tested.

Figure 2 brings out clearly the fact that the tempo of wilt development for all varieties in a given location and season differs markedly from that of a comparable group of varieties in a different season. At the Cotton Branch Experiment Station in 1930 there was a rapid, then a slow, and finally a rapid tempo of disease development; in 1932 there was first a rapid tempo, then a slow one for the remain-

der of the season; and in 1933 in general the tempo was fairly uniform throughout the season. This shows that even in the case of a soilborne disease, seasonal weather has a potent influence on the course of seasonal development as well as in the gross amount of wilt occurrence. It can be readily seen that a wilt count on July 5-8 would give no indication of the subsequent rate of wilt increase or the final amount at season's end. It is to be hoped, however, that a further study of symptoms and weather as it conditions wilt development might enable the observer to project the course of disease into the future, as has been done for wheat leaf rust, and thus lay the groundwork for forecasting the progress of the wilt disease.

The figure also shows that the factors for wilt resistance operate uniformly throughout the growing season since the tempo of wilt development in the resistant varieties agrees with that in the susceptible varieties at all times of observation, the only consistent difference being that the level of wilt incidence is consistently lower in the resistant varieties.

In Figure 3 are given the graphs of four experiments of the Arkansas workers in each of which a single cotton variety was grown on wilt-infested soil that had been given various fertilizer treatments. These treatments raised or lowered the level of wilt infection in each experiment but in no case is there a marked change in the tempo of wilt development associated with the fertilizer treatments. The fertilizers appear to raise or lower the threshold of infection throughout the growing season without changing the character of the course of disease development.

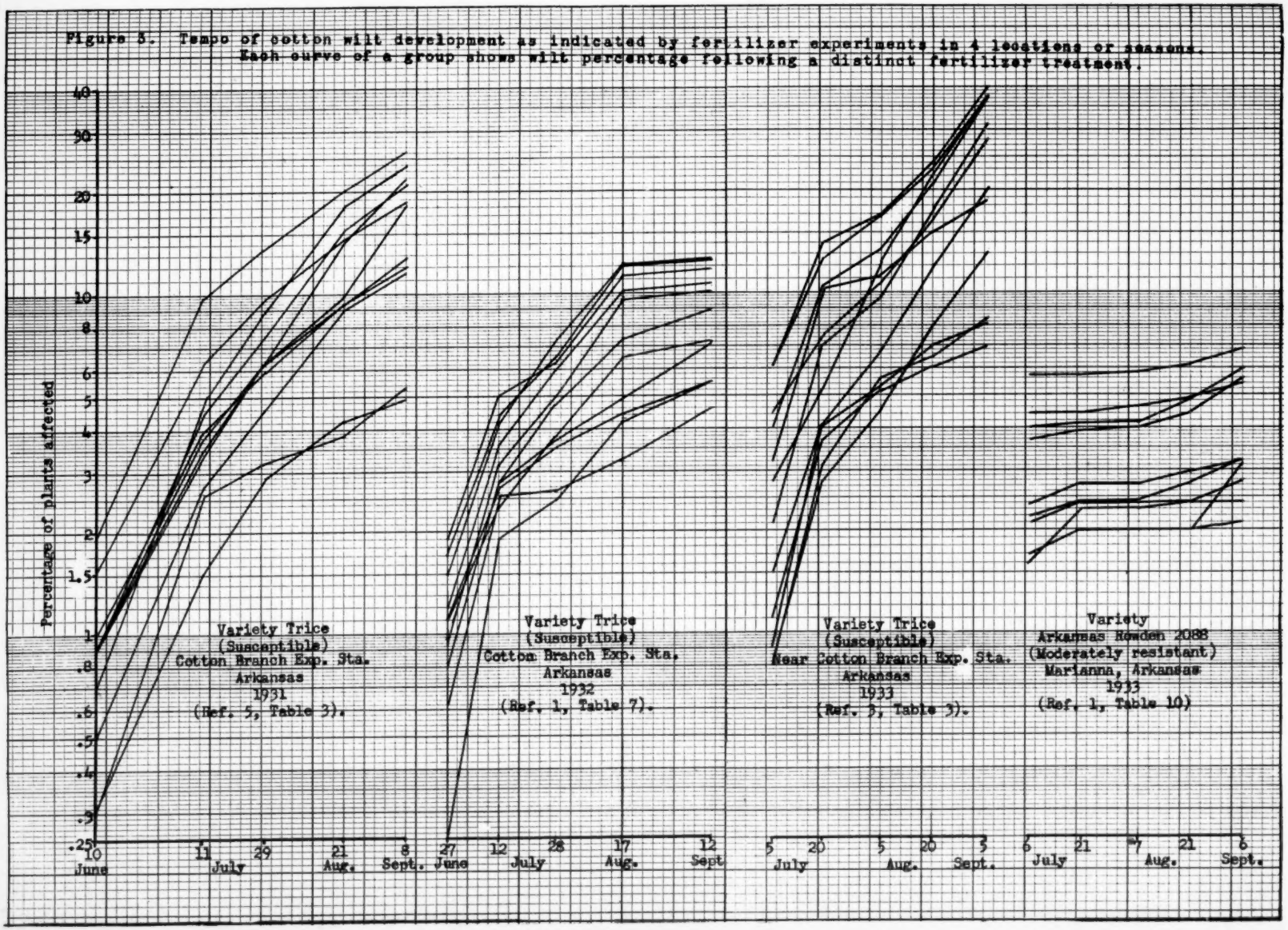
In brief, this study shows that the tempo of disease development appears to be a function of the seasonal weather, unrelated to varietal disease reaction or to soil constitution, and from one season to another the tempo of disease development varies widely, but uniformly for all varieties in one soil or for one variety in all soils.

It would be of great interest to determine whether these principles apply to the tempo of development of other soilborne diseases, and particularly to discover how they apply to airborne, in contrast with soilborne diseases.

## Conclusions

It has been shown that cotton wilt data, recorded in the interest of wilt control through use of varietal resistance, supplemented by those from tests of wilt control by soil amendments, are a good source of information on the amount of loss caused by wilt and on the tempo of wilt development as affected by variety, soil, and season, provided these data are reanalyzed with these objectives in mind.

Figure 5. Tempo of cotton wilt development as indicated by fertilizer experiments in 4 locations or seasons. Each curve of a group shows wilt percentage following a distinct fertilizer treatment.



In the literature of plant pathology there must be many other such bodies of data, dealing with other diseases, which might be reworked in similar fashion, and furnish valuable and much-needed information on the extent of loss due to plant disease.

This study brings out the importance of recording complete data on the course of disease development and its effect on the crop, since we cannot foresee the practical applications, distinct from those that motivate our present research, to which our data may, in the future, contribute. Where facilities for publication are limited, microfilm repositories of extensive data may provide the best means for making them available for future students.

At the St. Louis meeting of the American Phytopathological Society, a group of pathologists[1] who are particularly interested in the measurement of plant disease losses discussed the problem in detail and agreed to work together informally for the coming year to develop plans for formal projects on future activity in this phase of phytopathology.

This group invites the cooperation of any other pathologists who may have interest in the economics of plant disease and more accurate appraisal of plant disease losses to correspond and share in these informal efforts. In particular the group would appreciate having references to measurements of plant disease intensity and loss or to data which might be reanalyzed from this point of view, in domestic or foreign literature. In addition it is hoped that pathologists who are making intensive studies of specific plant diseases will include measurements of disease intensity and loss in those studies and that sufficient and appropriate data in disease control experiments and demonstrations will be recorded that they may serve to extend our knowledge of this important aspect of plant pathology.

## Summary

1. An extensive body of published data from Arkansas on cotton Fusarium wilt incidence in variety and fertilizer tests has been reexamined for the light shed upon disease-yield relationship and the tempo of disease development.

2. The data from variety tests show that, on the average, for each 5% increment in wilt percentage, up to 60% wilt, there is approximately a 3% loss in seed cotton harvested. Figure 1 is a means for more accurately appraising the amount of loss from wilt.

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[1] G. H. Boewe, K. Starr Chester, J. H. Miller, Paul R. Miller, and Ian Tervet, with advice from J. G. Leach.

3. Analysis of data from fertilizer tests shows that when cotton suffered from both wilt and soil deficiency (primarily lack of potassium), the yield reduction was approximately twice that from wilt alone, up to 25% wilt; at higher wilt percentages, most of the loss could be attributed to wilt.

4. The plotting of wilt incidence on successive dates on semilogarithmic paper brings out to advantage the tempo of wilt development with advance of the season. This tempo appears to be a function of seasonal weather, unrelated to varietal disease reaction or soil treatment, but varying greatly in character from one season to another.

5. It is suggested that there may be other bodies of data dealing with other diseases, which might be reworked in similar fashion, and furnish muchneeded information on the extent of loss due to plant diseases. The importance of recording complete data on the course of disease development and its effect on the crop is stressed.

6. A group of interested pathologists is informally cooperating in the planning of future studies and projects on the measurement of plant disease intensity and loss, and the cooperation of other pathologists is invited.

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## MAY WEATHER

(From U. S. Department of Commerce, Weather Bureau, Weekly Weather and Crop Bulletin for week ending June 4, 1946.)

Map I shows that the month of May 1946 averaged cooler than usual over practically the entire region from the Rocky Mountains eastward over the central valleys to the Appalachians and sourthward nearly to the Gulf, with monthly departures of 4° below normal in sections of Iowa, Missouri, Kansas, Nebraska, eastern Wyoming, and some adjacent areas. Temperatures averaged from near normal to somewhat above in Atlantic and Gulf coastal areas, in Florida, along the southwestern border, and in the Pacific States; the plus anomalies exceeded 4° in north-central Pacific areas.

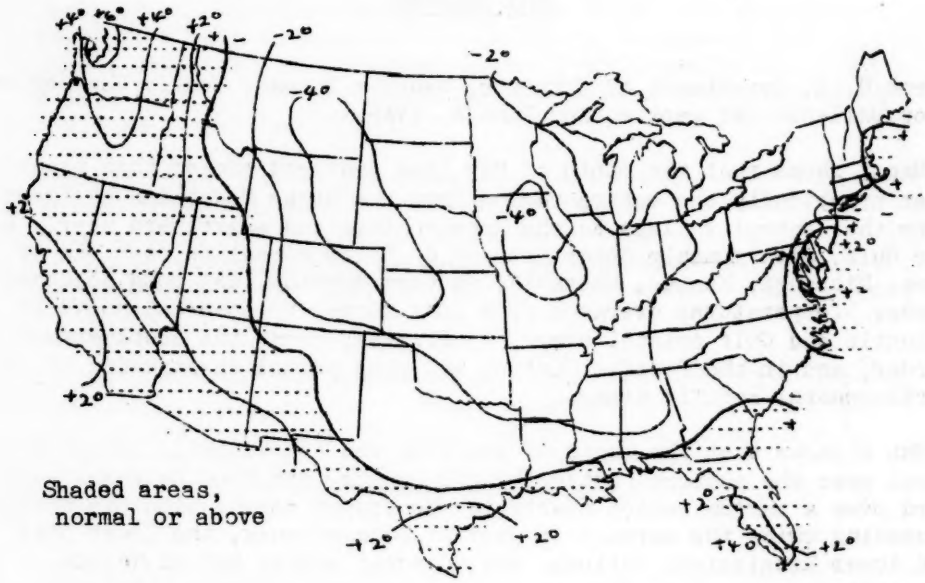
Map II shows that the month of May 1946 was considerably wetter than usual over the eastern portion of the country and from Nebraska westward over a narrow region nearly to the Oregon coast, with the totals exceeding twice the normals in most of Pennsylvania, the lower Ohio and lower Mississippi Valleys, and adjacent areas, and in Nevada. Precipitation was less than normal in the more northern portion of the country west of the Great Lakes, in most of Iowa, and from Kansas, western Oklahoma, and western Texas to southern California. Most stations in the far northwestern border districts and the Southwest received less than half of their normal amounts, with some stations in Arizona reporting no measurable precipitation during the month.

## SPRING WEATHER

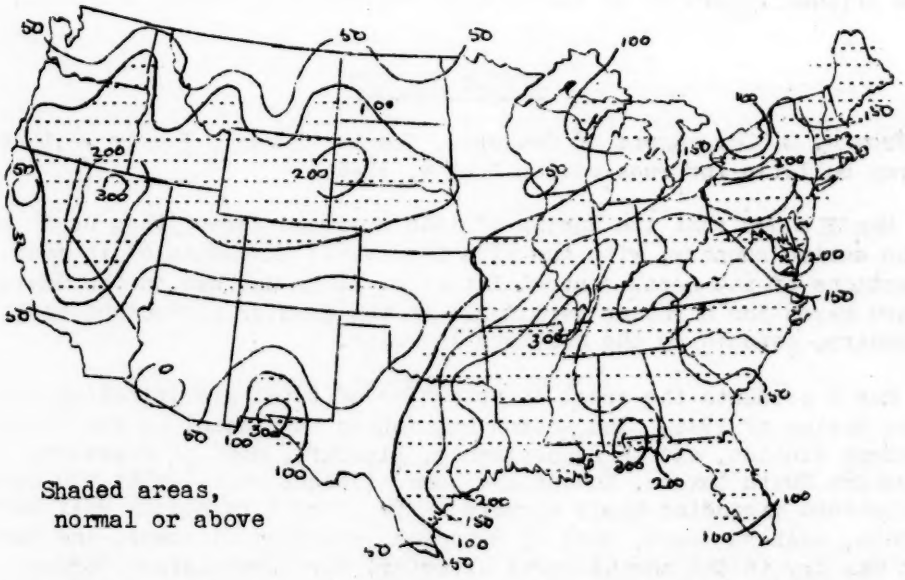
(From U. S. Department of Commerce, Weather Bureau, Weekly Weather and Crop Bulletin for week ending June 4, 1946.)

Map III shows that the Spring of 1946 averaged warmer than usual over the entire country, with the plus departures exceeding 6° in many sections of the north-central Interior. This was due to the unusually warm March and a rather warm April in the greater portion of the country, especially the northern Interior.

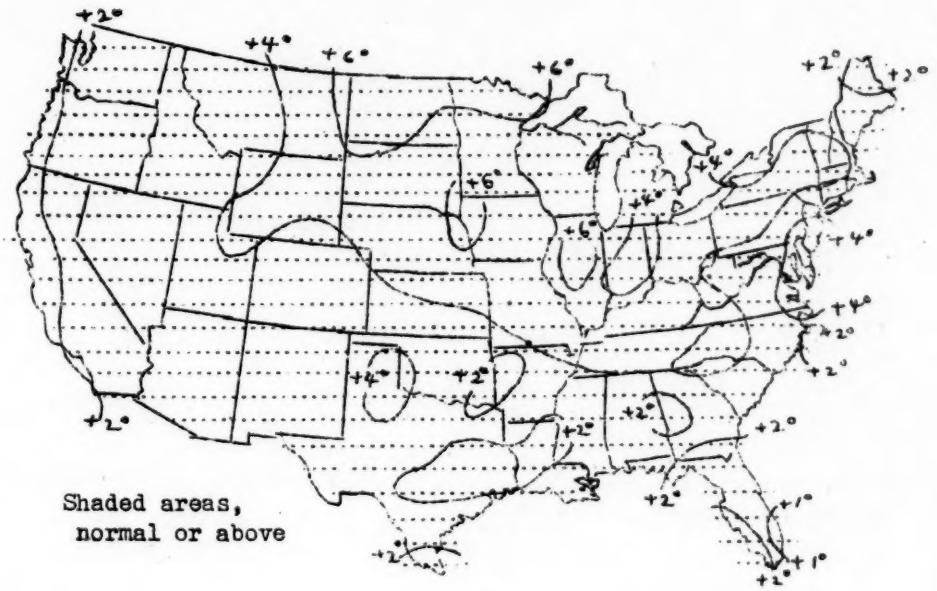
Map IV presents the areal distribution of total precipitation for the Spring of 1946. The season was wetter than usual in the South, except Florida, and in Pennsylvania, Missouri, most of Nebraska, western South Dakota, Nevada and some adjacent areas, with the accumulations exceeding their normals by 50 percent in middle Gulf Coastal areas, eastern Texas, much of Arkansas, southern Missouri, and Nevada. It was dry in the northcentral Interior, far northwestern Border States, and the Southwest, including northwestern Texas, western Oklahoma, and western Kansas.



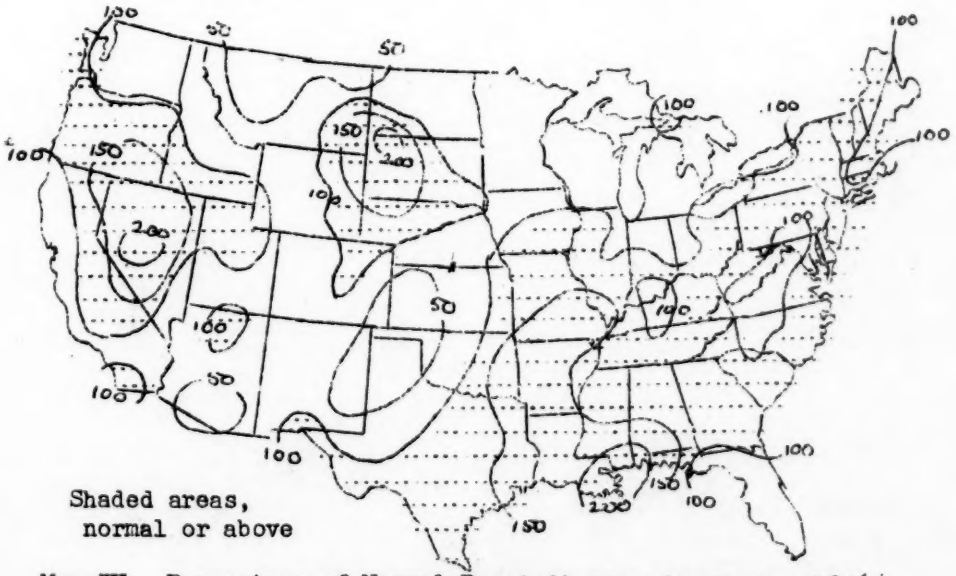

Map I. Departure of Mean Temperature from the Normal for May 1946




Map II. Percentage of Normal Precipitation for May 1946




Map III. Departure of Mean Temperature from the Normal for Spring 1946.




Map IV. Percentage of Normal Precipitation for Spring 1946.